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RICARDO

AVTA Vehicle Component Cost Model

2009 DOE Hydrogen Program and Vehicle Technologies Annual Merit Review

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Ricardo/ Argonne National Laboratory

Sponsored by Lee Slezak

Project ID VSS031

Project Overview

Problem Statement

- Association of costs to technologies requires:
  - Clearly articulated, common assumptions for both cost and performance modeling
  - Cost driver basis (e.g. volume, cumulative units, raw materials)
  - Flexible, updatable model allowing continuous reassessment of changes vs. conducting new clean sheet study

Timeline

- Start: April 2010
- Complete: July 2010

Budget

- $750k

Partners

- US Department of Energy
- Argonne National Laboratory
- Idaho National Laboratory

Objectives

- Defensible, accessible data is necessary to allow proper peer/ industry reviews of proposed policymaking
- System vs. component view of technology applications yield different results
- Rapid technology advancements and shifting economics obsolete static ‘snapshots’ of cost-performance
- Context of cost results is required to understand applicability

Approach

Model Definition

Model Scoping:
- Identify technologies of interest
- Define analysis time frame
- Identify all applications

Applications Segmentation:
- Define performance criteria of applications
- Group applications by similar performance criteria

Technology Path Development:
- Define baseline technology content within each application
- Identify technologies and technology combinations appropriate to each application
- Develop routes (sequential or parallel) to deployment of identified technologies

Baseline System Impact Analysis

BoM Assumptions Development:
- Identify key cost drivers
- Identify baseline demand level
- Identify introduction timing
- Select baseline application(s)
- Define incremental content required for each technology package

BoM Cost Analysis:
- Current state cost analysis

Industry Benchmark Pricing

Feature Based Costing

Manufacturing Based Costing (DfA)

Other Cost Models

BoM Performance Analysis:
- Performance analysis

Technology Modeling

Powertrain Modeling

Vehicle Modeling

BoM Iteration

BoM definition adequate

No

Yes

Full Impact Analysis

Application Extension:
- Identify application characteristics to walk cost/ performance
- Define characteristics of each application

Synergy Identification:
- Identify technology combinations that impact cost/ performance

Cost Overlays:
- Retail price vs. material cost
- Manufacturing efficiencies
- Design efficiencies
- Raw material forecasts
- …

Sensitivity Analysis

Cost-Benefit Models Complete:
- Time frame of interest
- All applications
- All technologies

STOP

The Model Definition phase focuses the project on critical path technologies within the time period of interest

Model Scoping

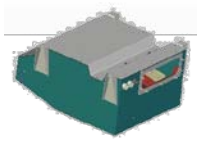
- Identify all applications
  - *e.g. Passcar & LDT*
- Define analysis time frame

2010 → *2020*

- Identify systems of interest


Engine


Transmission


Hybrid Electric

- Identify technologies of interest

Engine
- *Discrete Variable Valve Lift*
- *Cylinder Deactivation*
- *Boosted/ Downsized*

Transmission
- *Shift logic improvement*
- *AMT*
- *DCT*
- *…*

Hybrid Electric
- *12V Microhybrid*
- *42V Stop-Start*
- *Plug-in Hybrid*
- *…*

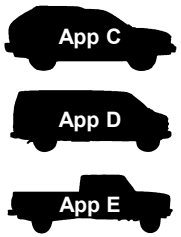
Segmentation

- Define performance criteria of applications
  - *e.g. tow capability*
- Group applications by similar performance criteria

Vehicle segmentation

No Tow Capability

Tow Capability



-or-

Duty cycle segmentation

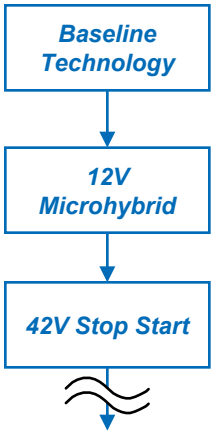

Line Haul


Metro


Military Logistics

Technology Path Development

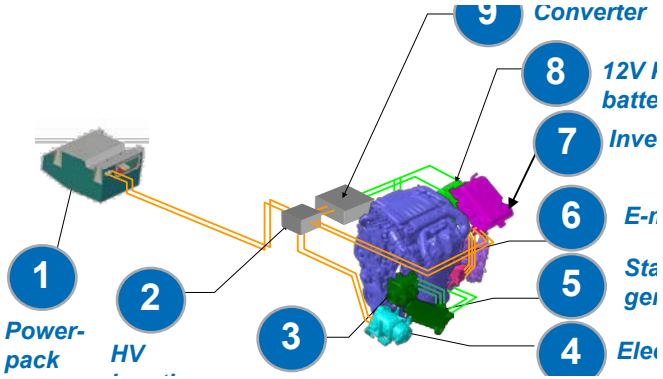
- Define baseline technology content within each application
  - *e.g. 12V electrical, auto trans*
- Identify technologies and technology combinations appropriate to each application
- Develop routes (sequential or parallel) to deployment of identified technologies



The Baseline System Impact Analysis phase iterates and develops a specific BoM as Cost and Performance Modeling progress

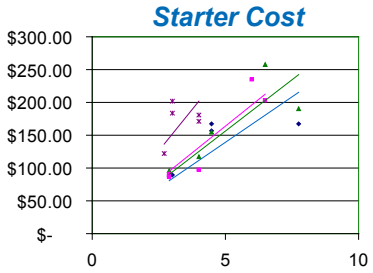
BoM Development

- Identify key application requirement cost drivers (e.g. specific power, max temperature, battery shelf life)
- Identify baseline demand level
- Identify introduction timing (e.g. mid-cycle refresh, new architecture)
- Select baseline application(s)
- Define incremental BoM required for each technology package

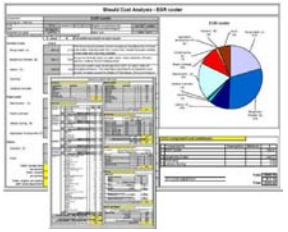


Cost Analysis

- Use of Multiple Sources Required
  - Industry Benchmark Pricing
  - Feature Based Costing



  - Manufacturing Based Costing (DfA)

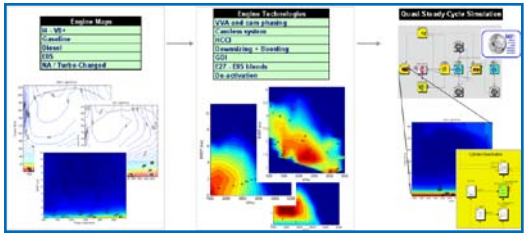


  - DoE technology cost models

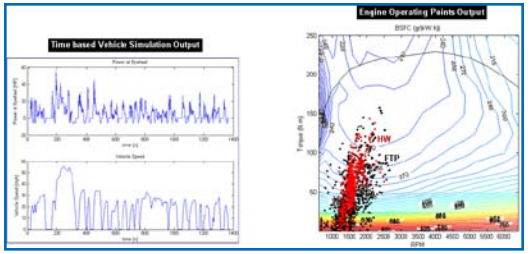
Iterate

Performance Analysis

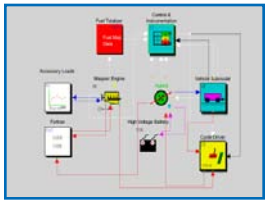
- Technology Modeling



- Powertrain Modeling



- Vehicle Modeling



HEV Modeling

The Full Impact Analysis phase extends the modeling across all applications and accounts for synergies and other model impacts

Application Extension

- Identify application characteristics to allow cost/ performance walks from baseline technologies

HEV Example

DC/DC converter cost→
Scales w/ curb weight

High voltage wiring cost→
Scales with vehicle footprint

- Define characteristics of each application

	Curb weight (lbs)	Foot-print (ft3)
App B	3,359	44.5
App E	5,366	62.6

Synergy Identification

- BoM Iterations performed for technology combinations
- Cost synergies identified

Discrete Variable Valve Lift

BoM

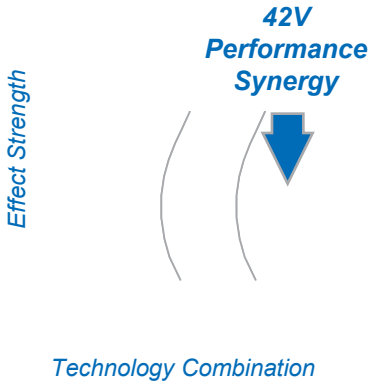
Qty	Part	Unit Cost
6	Motion Ctrl Device	18
1	Control valve	10
1	Cam position sensor	4

Cylinder Deactivation

BoM

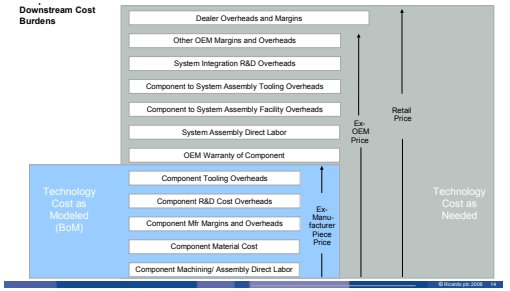
Qty	Part	Unit Cost
1	Active mount set	30
6	Motion Ctrl Device	18
1	Control valve	10

- Design of Experiments based interaction effects analysis with constraints
- Performance benefit synergies identified

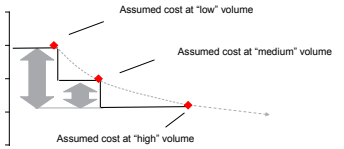


Cost Overlays

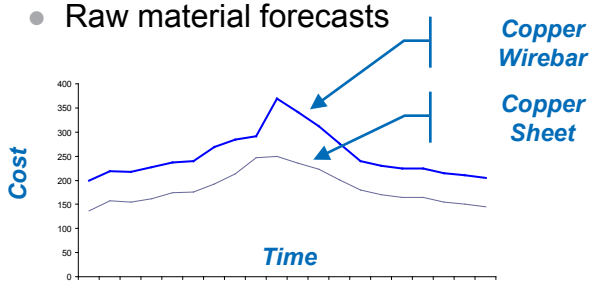
- Retail price vs. material cost



- Manufacturing efficiencies
- Design efficiencies (e.g. learning curves)

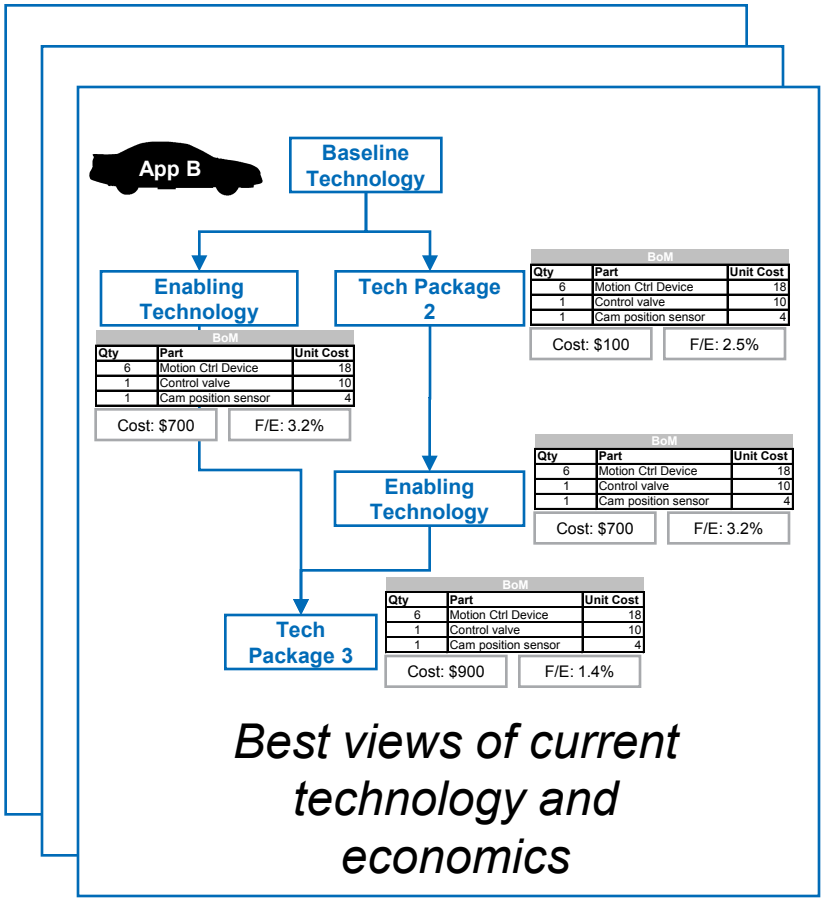


- Raw material forecasts



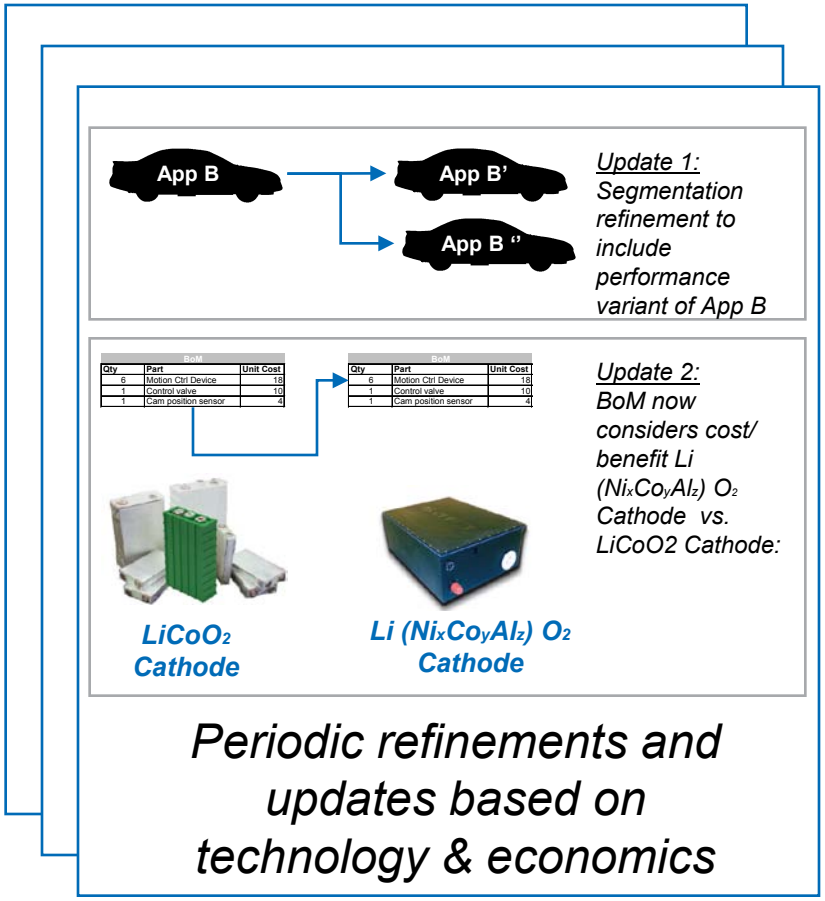
Model transparency and "cost-driver" basis permits updates and maintenance

Model Development



Best views of current technology and economics

Model Updates



Periodic refinements and updates based on technology & economics

Milestones

Milestones (2010)		Description
Kick-off Meeting		Project start
Program Execution Plan Confirmation		Program Execution Plan (PEP) confirming the scope of work and cadence of project activities to be accomplished throughout the remainder of the project period including items listed
Cost Model BETA Version		Provide preliminary BETA version of cost model for (1) technology package as applicable to (1) vehicle platform
Cost Model BETA Version		Provide: (A) preliminary BETA version of cost model for all prioritized technology packages for one (1) vehicle platform and, (B) report describing final technology scaling methodology to be employed for vehicle technologies across all relevant vehicle classes
Cost Model BETA Version		Provide preliminary BETA version of cost model for all technology packages on at least two (2) vehicle platforms preferably diverse vehicles including at least one car and one truck/sport utility vehicle)
Project completion		Provide final cost model assessment tool and documentation defining all assumptions used in the development of the tool and describing the methodology used within the tool

Contact details

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