

estimate

estimate • analyze • plan • control

CAD Model & Parametric Cost Model Integration – A Case Study

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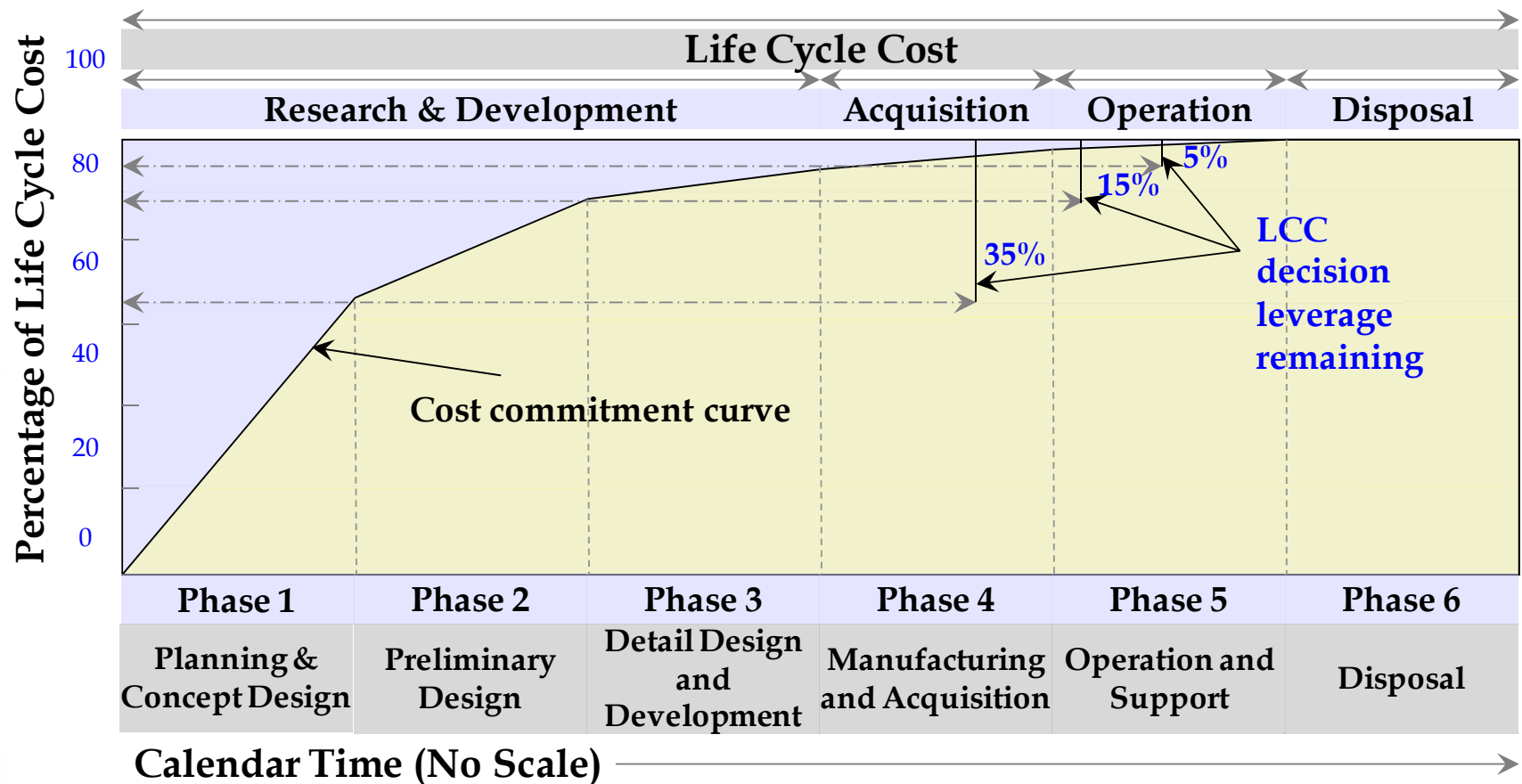
Project Motivation

- Provide real time cost feedback to engineers
- Enable non cost engineers to develop cost models automatically
- Enable engineers and managers to perform more design trade studies in a shorter time frame
- Support decision making when the opportunity to reduce cost is at its highest
- Influence the 'go' or 'no – go' decisions...
- Cost Engineers Dream..?



Project Motivation Cont...

- Cost Commitment Curve





Parametric Cost Modeling

- Dates back to the 1950's;
 - Introduced by the RAND Corporation for the US Air Force
 - Widely used by Government and Industry
- Uses historical samples to establish statistical relationships
- Uses the past to predict the future
- Linear regression most popular & simplest technique $y = a + b(x)$
- Typically used during the product development stages
- Reduces time required to produce estimates



SEER for Hardware Cost Model

- Uses Parametric Algorithms
- Provides estimation of product development, production, operations, support, and system costs to Government & Industry
- Built in Knowledge Bases
 - Provide parameter inputs before you know details
 - Excellent for quick estimation and tradeoffs
 - Contain relevant ranges of inputs, calibration, and sanity information
 - Create User Defined Knowledge Bases
- Calibration Tools enable Customization to particular experience and expertise

SEER for Hardware User Interface



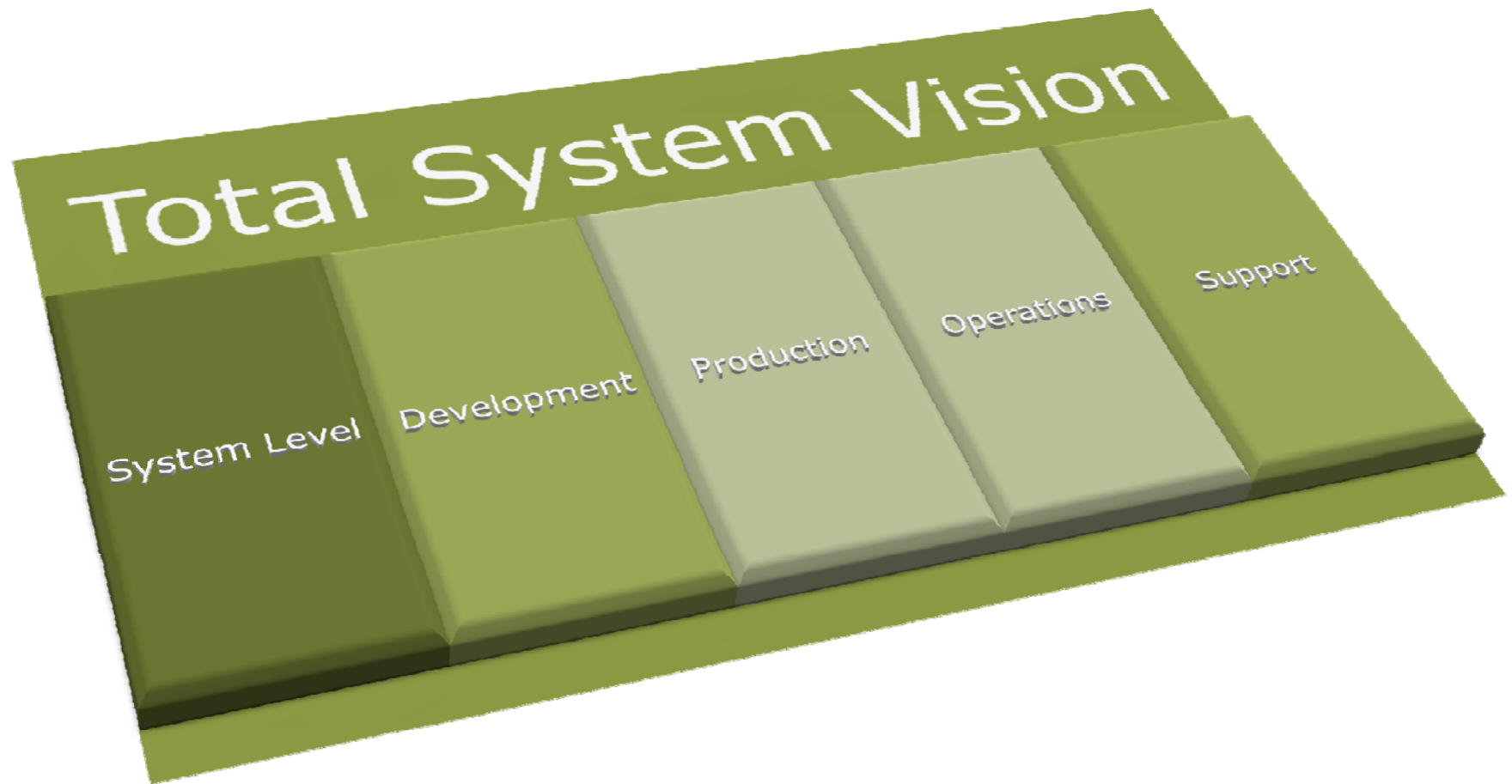
The screenshot displays the SEER software interface for a hardware project. The main window is titled 'computer.har - SEER-H' and contains several panes:

- Work Elements:** A tree view showing the project structure, including '1 Computer', '1.1 Equipment Configuration', and '1.1.1 Internal Computer'. The '1.1.2.3 Monitor/Video Housing' item is highlighted.
- Parameters - MECH: Monitor/Video Housing:** A table showing various parameters and their values for three different scenarios (5.00, 6.00, 8.00).

Parameter	5.00	6.00	8.00
Weight (lb)	5.00	6.00	8.00
Volume (cubic feet)	0.00	0.00	0.00
MATERIAL COMPOSITION			
Percent Aluminum/Malleable Metal	0.01%	50.00%	100.00%
Percent Steel Alloy			0.00%
Percent Commrcl Available Exotic			0.00%
Percent Other Exotic			0.00%
Percent Composite			0.00%
Percent Polymer			100.00%
Percent Ceramic			0.00%
Complexity of Form	VLo	VLo+	Nom
Complexity of Fit	Nom	Hi	Low
Construction Process			VHi
MISSION DESCRIPTION			
Operating Environment	Ground		
Hardware Classification	Secondary Structure		
Operating Service Life	50,000	60,000	100,000
Internal Pressure (PSI)	0	0	0
PROGRAM DESCRIPTION			
New Design	0.01%	0.01%	0.01%
Design Replication	0.00%	0.00%	0.00%
- Quick Estimate:** A table comparing 'Result' and 'Enclosure Reference' values.

	Result	Enclosure Reference	
Development Cost	2,704	1,955	38%
Development Labor Hours	30	21	41%
Production Cost	55,913	42,817	31%
Total Production Units	6,000	6,000	0%
APUC	9.32	7.14	31%
Total Equipment Support Cost	889	48,769	164%
Element Weight	17	5.00	23%
- Development Cost Risk:** A line graph titled 'Monitor/Video Housing: Development Cost Risk'. The Y-axis is 'Dev. Cost' (0 to 7000) and the X-axis is 'Probability (%)' (0% to 70%). The graph shows a curve that starts at approximately 1200 at 0% probability and rises to about 6500 at 70% probability.

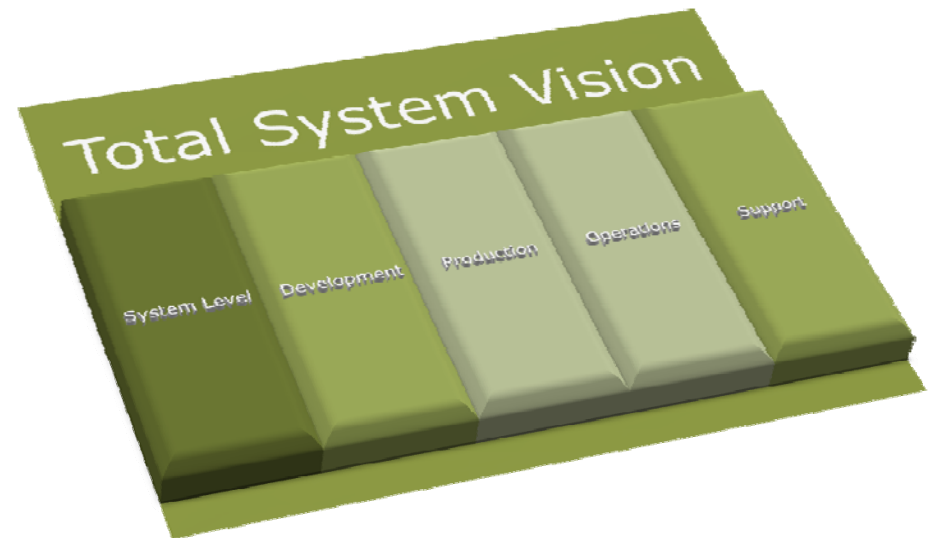
What does SEER for Hardware Estimate?



What does SEER for Hardware Estimate?



- System Level Cost estimation
 - System program management
 - System engineering and integration
 - System test operations
 - System integration, assembly and test
 - System support equipment
- Development estimation
 - Design
 - Prototypes
 - Tooling
- Production estimation
 - Direct Labor--fabrication, integration, assembly
 - Indirect Labor-
 - Material--raw materials, purchased components



- Operations & Support scenario estimation
 - Program schedule
 - Product reliability
 - Product maintainability
 - Product availability



CAD Models

- Pro Engineer Wildfire 3.0
 - Parametric Technology Corporation (PTC)
- CATIA
 - Dassault Systemes
- Unigraphics NX
 - Siemens PLM Software
- Which CAD model?
 - To use a CAD API, one must become a CAD Vendor 'Partner'
 - PTC (Pro Engineer) was selected as the first system with which to integrate





Methods of Integration

- Export data from CAD to a third party tool, analyze/format data and then import to Cost Model
- Use a third party tool such as iSight, or Model Center
- Direct integration using CAD Application Programming Interface (API) and cost model (API)
 - Used in this Case Study
 - Provides the most seamless integration



Understanding Pro/E API

- C++ Programming language was required
- Types of API documentation
 - HTML, and PDF documents (sometimes difficult to follow)
- API technical support
 - Phone (indirect access), emails & website (slow to respond)
- The API can be used to control and access most of the common application functions
 - Material properties, mass properties, etc.
- Basic dialogs and controls can be used via the API e.g. Combo boxes, list boxes, text boxes etc.
 - Advanced controls were not available in version 3.0, e.g. Tree Controls

Understanding SEER API (Server Mode)



- Server Mode is an alternative to the SEER interactive, graphic, user interface
- It uses a stream of commands that are run from either the clipboard, a text file, or an Automation Interface
- It is typically used to Integrate, Run, and/or Create SEER estimates from applications such as requirements tools, spreadsheets, project management tools, ERP systems, or CAD tools
- Is based on simple to use commands making it quick and easy to learn:
 - ProjectCreate, WBSCreate, Exit etc.



SEER Automation Interface

- Automation Interface (Preferred Integration Method - Used in this Case Study)
 - The OLE Automation interface allows you to run SEER directly from an OLE-compatible application
 - Uses the RunCommands() method
 - Example:

```
Sub RunSEER()
```

```
    Dim Seer as Object
```

```
    Set Seer = CreateObject("SEER-DFM.Document")
```

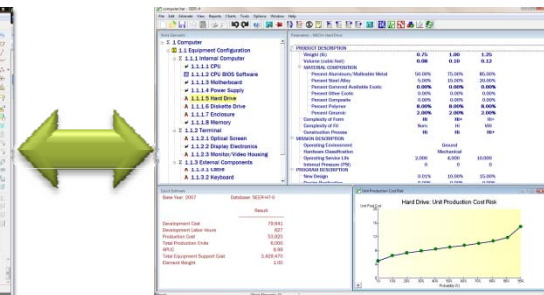
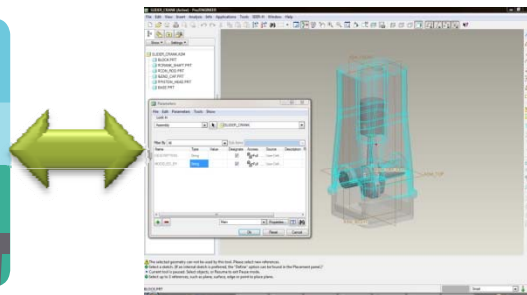
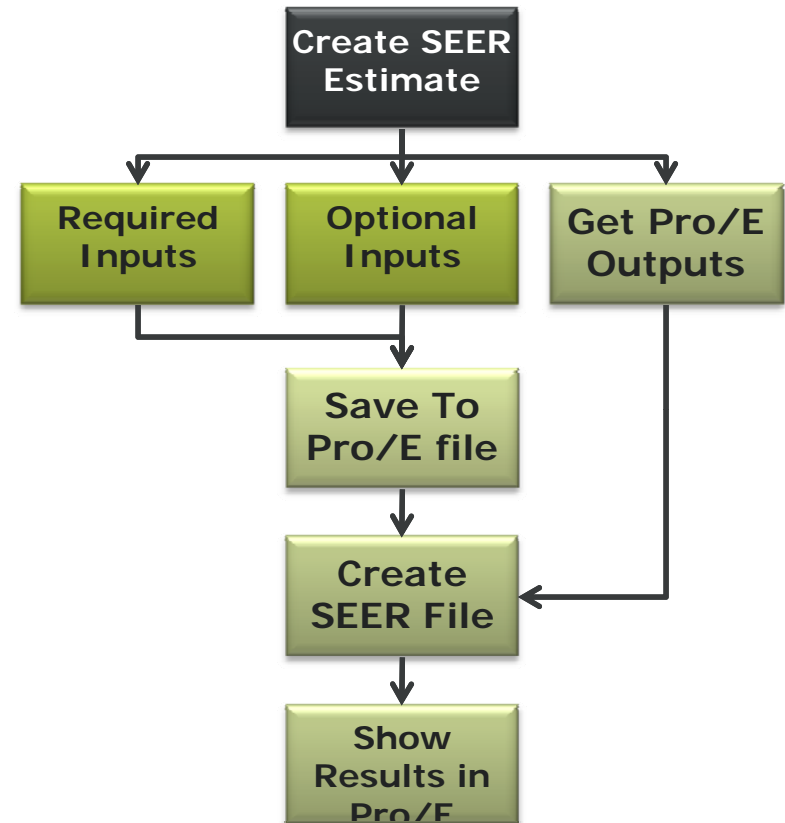
```
    Seer.RunCommands ("LoadFile" & vbTab & "samples\gfault.dfm")
```

```
    Seer.RunCommands ("FlexportOutput" & vbTab & "OUTSUMM.flx" &  
vbTab & "C:\temp\Results.txt")
```

```
End Sub
```

Integration Process Overview

- Develop Requirements Spec
- Design New Pro/E Menu Option
- Logic Flow Diagrams
- Rules & Error Traps
- Dialogs



SEER Inputs – Required and/or Optional



ITEM	QUANTITY
Prototype Quantity	10
Production Year 1	500
Production Year 2	1000
Production Year 3	1000

Selected Element	Type
BLOCK	PRT
CRANK_SHAFT	PRT
CON_ROD	PRT
END_CAP	PRT

Knowledge Bases

Application: !~Mechanical General

Platform: Ground-Fixed

Acquisition: Make

Standard: Military - Full

Custom:

Required

Defaults Provided

Selected Part: CON_ROD

Parameters	Value
+ PROGRAM SCHEDULE	
- Required Development Sched (Mos)	
- Start Date for Development	
- Quantity Per Next Higher Element	
- Start Date for Production	
- Production Learning Curve	
- Prior Production Units	
- Stop Learning Quantity	
+ ENGINEERING HOURLY RATE	
- Development Management Hourly Rate	
- Systems Engineering Hourly Rate	
- Design Engineering Hourly Rate	
- Prototype Engineering Hourly Rate	
- Test Engineering Hourly Rate	
- Tooling Engineering Hourly Rate	
- Development Support Hourly Rate	
+ MANUFACTURING HOURLY RATE	
- Production Management Hourly Rate	
- Fabrication Hourly Rate	
- Assembly Hourly Rate	

Optional:
Used to
Refine
Estimate

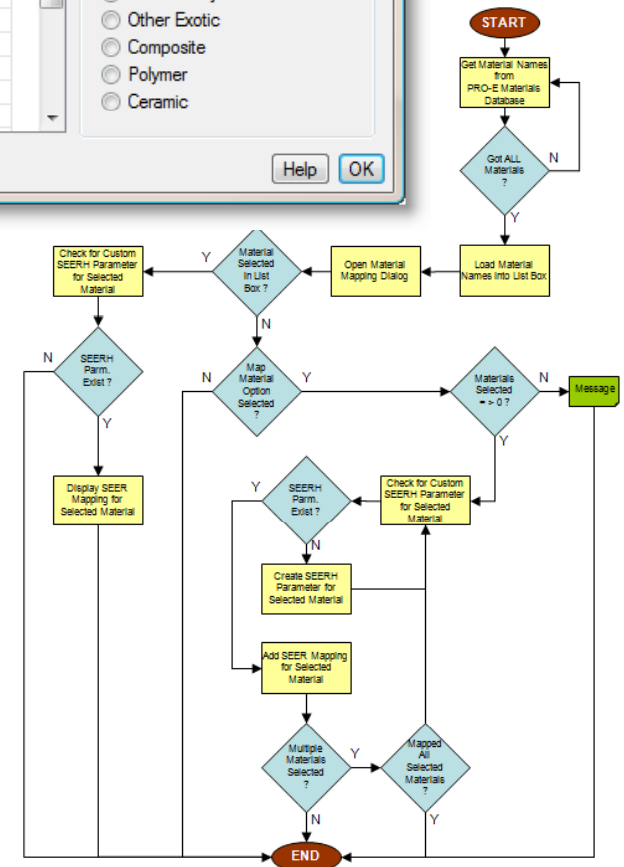
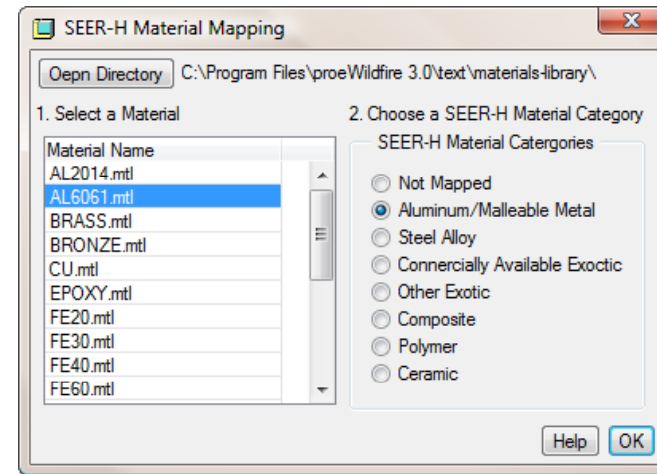
Pro/E Outputs used as SEER Inputs



- Mass
- Volume
- Unit of Measure
- Assembly 'Tree' Structure
- Material Types (See Material Mapping)
- Number of Parts in Assembly (For Integration)
- Previously Saved Data
 - Each time an estimate is Run from Pro/E, the inputs used to generate the estimate are saved with the Pro/E file
 - Especially useful when building Assemblies from Parts

Material Mapping Feature

- SEER-H uses Material Categories
- User dialog developed for mapping materials to SEER-H material categories
- Required additional programming logic to determine percentage of material types in an assembly



Pro/E to SEER for Hardware Live Demo



Provide Engineers with immediate cost feedback for alternative assembly and part design configurations

SEER Estimates reported to engineer in Pro/E

SEER for Hardware Cost Model generated from Pro/E file

Custom SEER interface fully integrated in the Pro/E environment

Work Element Name	SLIDER_CRANK
Total Production Units	3,000
First Unit Cost	25,740.96
APUC	8,031.05
	9,347
	28,040,997.75
	2007
	9,347
	28,040,997.75

Total	Elapsed Months
2,514,252.25	12.23
1,882,679.09	
256,585.66	
477,589.78	
68,626.64	
40,853.9	
94,111.11	
133,797.35	
26,838.17	
4,673.35	

Result			
Development Cost	1,882,679		
Development Labor Hours	11,294		
Production Cost	24,093,137		
Total Production Units	3,000		
APUC	8,031.05		
Operating Site Cost	0		
Total Equipment Support Cost	0		
System Level Development Cost	631,573		
System Level APUC	478		
Total System Level Cost	2,085,182		



Summary

- The SEER for Hardware Parametric Cost Model is well suited for CAD model integration – as proven by this case study
- Direct integration to a CAD model means you must have a separate integration for each CAD system (API) you integrate with
- Integrating Parametric Cost Models with CAD models:
 - provides engineers with immediate cost feedback during the design process
 - enables automatic cost model generation, which can be modified and refined by cost engineers
 - facilitates the design trade study process



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