



**United Technologies**

# INTEGRATING EHS INTO NEW PRODUCT DEVELOPMENT

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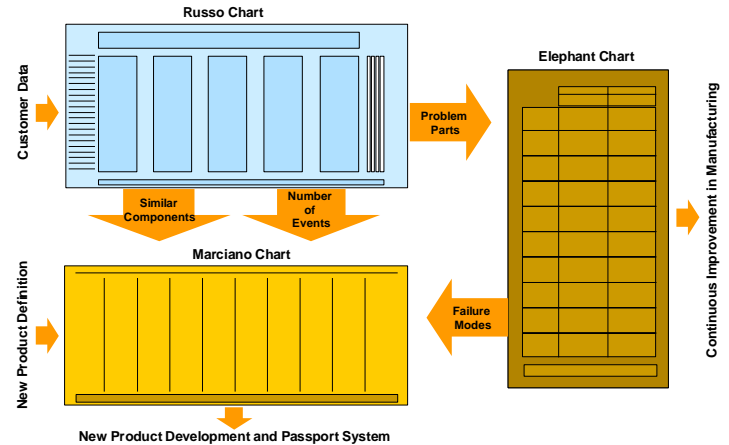
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# DFES ROADMAP



Integrated DFES/ DFx

Disciplined execution using Passport

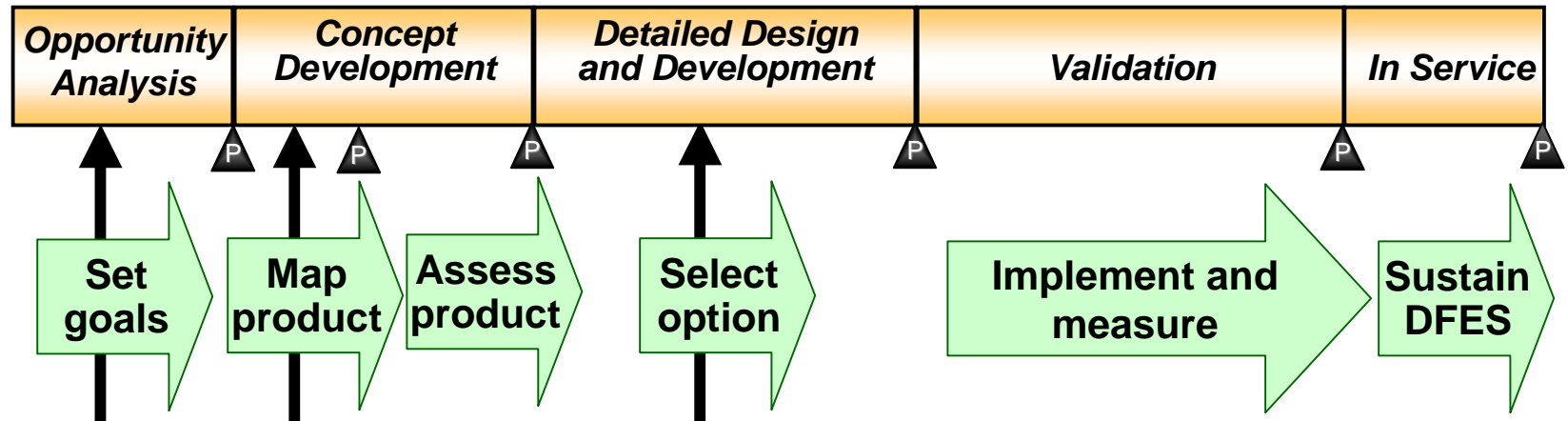


Unsatisfied stakeholder needs define innovation opportunities

•Systems	•Components	Defining	Segmenting	Supporting	Candidate Technologies
Power Generation System	<ul style="list-style-type: none"> <li>Engine</li> <li>AC Generator</li> <li>Standby Module</li> <li>Fuels</li> <li>DC Supply</li> </ul>	<ul style="list-style-type: none"> <li>✓ Silence</li> <li>✓ Reliability</li> </ul>	✓	✓	<ul style="list-style-type: none"> <li>Low noise engine</li> <li>Electric power generation system</li> </ul>
Refrigeration System	<ul style="list-style-type: none"> <li>Compressor</li> <li>Coils</li> </ul>	✓ Reliability	✓		<ul style="list-style-type: none"> <li>Compact Hermetic compressor</li> <li>Alternator + Inverter + Rotary</li> </ul>
Control System	<ul style="list-style-type: none"> <li>Microprocessor</li> <li>Software</li> <li>Cab Command</li> <li>Control Box</li> </ul>			✓ ✓ ✓	<ul style="list-style-type: none"> <li>Modular CAN Bus</li> <li>Fleet Communication System</li> <li>Graphic LCD / Cab Command</li> </ul>
Air Management System	<ul style="list-style-type: none"> <li>Condenser fan</li> <li>Evaporator fan</li> </ul>	✓ Silence		✓	<ul style="list-style-type: none"> <li>Low noise Cond Fan</li> <li>Variable Speed Cond Fan</li> </ul>
Structure	<ul style="list-style-type: none"> <li>Skin</li> <li>Frame</li> </ul>	✓ Silence		✓	Noise insulation system

# DFES, Passport, and DFx

Create simple how-to guide



**Platform DFx**--Reduce complexity and improve EH&S performance for the *entire product line*

**Concept DFx**--Improve *strategic decisions* with impact on complexity and EH&S performance for the *product and the plant*

**Tactical DFx**--Improve *tactical decisions* with impact on complexity and EH&S performance for *components, parts, and processes*

# EXIT DECISION – APPROVAL TO SELECT SPECIFIC CONCEPT & PLAN PROGRAM

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- Has a reference product been selected to establish the EHS performance baseline?
- Have candidate technologies been evaluated for potential negative social and environmental impacts across product life cycle?
- Have market feedback data been reviewed to identify EHS contribution to resolving customer issues?
- Are key materials components procured from industry sectors that are under public scrutiny for safety or environmental concerns?
- Are there aftermarket opportunities for products and services related to meeting EHS requirements?
- Have downstream operations (mfg., service, disposal) been surveyed to identify unresolved problems in reference product?
- Has the preliminary DFES assessment matrix been completed and used to identify potential improvement opportunities?

# DFES STEPS & KEY ACTIVITIES

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## 2. Map life cycle of product system

- Select a reference product to provide baseline EHS data
- Refine the bill of materials and gather existing information on components & mfg. processes
- Create life cycle map of product system, focusing on processes with significant EHS impact
- Review the map with cross- function team, identify EHS hazards, & refine map as needed

## 3. Assess risks for product system

- Complete preliminary DFES matrix assessment to qualitatively rank and prioritize risks
- Conduct root cause analysis of priority risks
- Identify information gaps & conduct additional analyses as needed

## 4. Select improvement options

- Brainstorm improvement options
- Screen ideas for business value

# KEY SYSTEMS & EQUIPMENT

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## •Systems

## •Components

Power Generation System	<ul style="list-style-type: none"><li>• Engine</li><li>• AC Generator</li><li>• Standby Module</li><li>• Fuels</li><li>• DC Supply</li></ul>
Refrigeration System	<ul style="list-style-type: none"><li>• Compressor</li><li>• Coils</li></ul>
Control System	<ul style="list-style-type: none"><li>• Software</li><li>• Microprocessor</li><li>• Cab Command</li><li>• Control Box</li></ul>
Air Management System	<ul style="list-style-type: none"><li>• Condenser fan</li><li>• Evaporator fan</li></ul>
Structure	<ul style="list-style-type: none"><li>• Skin</li><li>• Frame</li></ul>

# PRODUCT ARCHITECTURE

	A	B	C	D	E	F
1	<b>System</b>					
2	<b>Component</b>	<b>Material Description</b>	<b>Comp. Wt</b>	<b>System Wt.</b>	<b>Manufacturing</b>	
3	<b>Cabinet &amp; Filter</b>					
4	Drain pan cover	Galvanized steel foam insulation			Self- adhesive bond; formed edges; holes	
5	Motor/blower cover	Galvanized steel insulation mat			Self- adhesive bond; formed edges; holes	
6	Drain pan	Molded PP foam gaskets			Self - adhesive bond	
7	Discharge panel	Galvanized steel 2 threaded inserts			Stamped openings	
8	Filter panel	Galvanized steel			Stamped openings	
9	Filter brackets (2)	Molded PP				
10	Air Filter	PS frame PE mesh			Molded panels; attach w/ screws	
11	Frame	Galvanized steel insulation mat			Punched openings; bending; self- adhesive bond	
12	screws	steel			zinc phosphate conv coat for corrosion	
13	<b>Air Distribution</b>					
14	Panel w/ motor bracket	Galvanized steel insulation mat			Punched & welded bracket; self- adhesive bond	
15	Fan cage (2)	Galvanized steel			spot weld	
16	Fan (2)	Aluminum steel hub				
17	Motor & shaft	Mixed; motor, wiring, capacitor, shaft & bearings				

Teardown Prod\_Structure HMI

Ready

# CHECKLIST SCREEN FOR PRIORITY ICONS

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## Example for 2 icons only



- Does product burn fuel or consume electricity during normal operation?
- Does energy cost have a significant impact on customer's cost of ownership?







- Does expected installation/ use impose size or weight restrictions on unit?
- Do warranty costs or quality data indicate problem parts?
- Do accident data indicate problem parts for assembly or service?

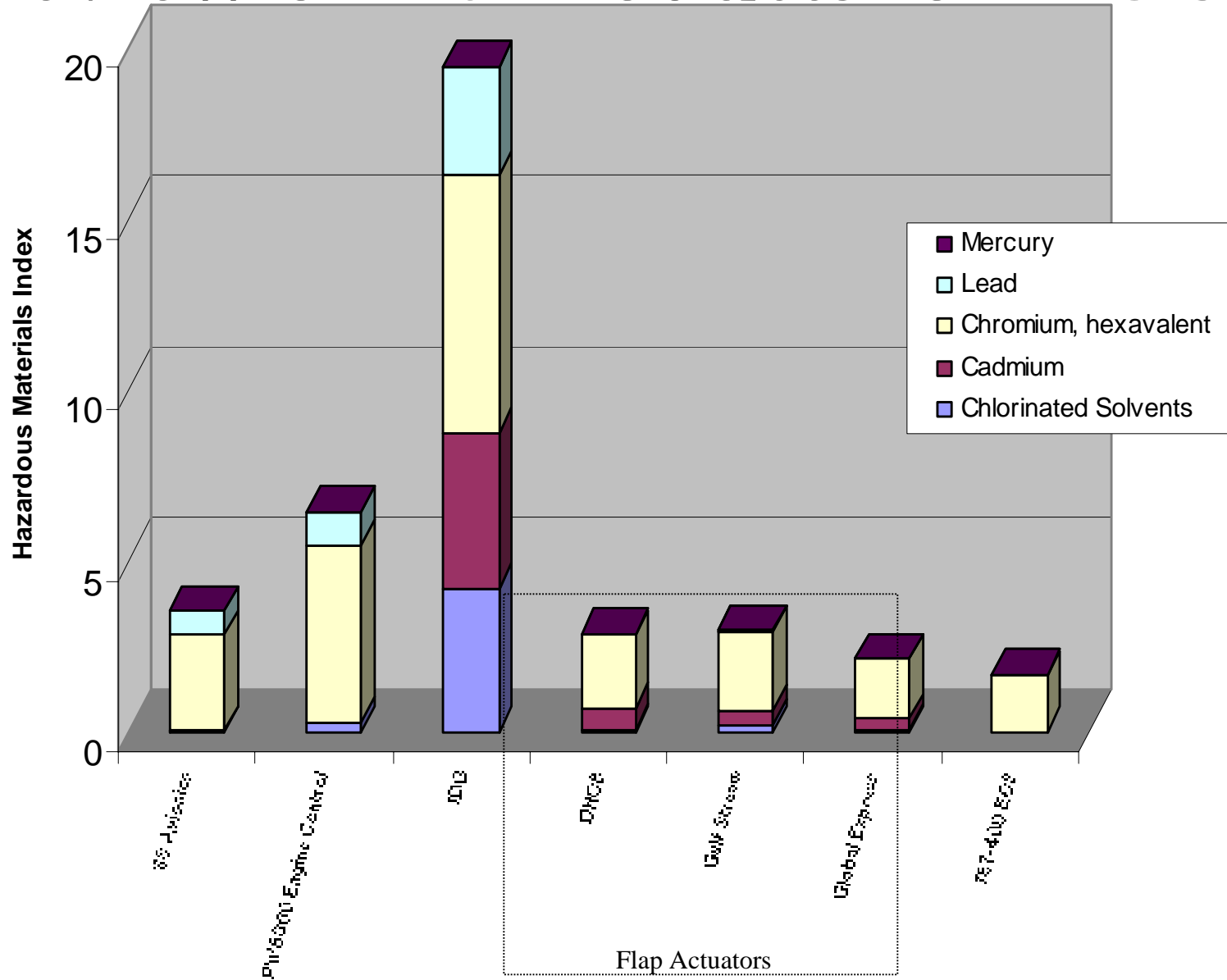


# VALIDATION CHECKLIST

## Questions linked to product environmental attribute icons

	<p>Is selected refrigerant compatible with ODS phase- out requirements and emerging customer demands for reduced global warming impact?          What is fleet impact due to field leakage rate?</p>
	<p>What is the size and weight reduction relative to the previous generation, or reference design?          What is the part count reduction?          Does the product meet WEEE requirement for 80% recycle?          Projected recycle rate =</p>
	<p>What is the expected total annual energy consumption for designed usage profile?          What is reduction relative to reference design?</p>
	<p>Are all toxic materials in final product identified and accessible for removal to enable separate waste disposal treatment?          HMI of final product =</p>

# Review of HS Products for MOCs



# SUPPLY CHAIN MANAGEMENT

The screenshot displays a Microsoft Excel spreadsheet titled "Supplier MOC Sheet 7242903.xls". The spreadsheet contains a "Supplier MOC information Report" with the following data:

Field	Value
Name of Supplier:	Acme Metal Finishing
Location of Supplier:	Toontown, CT
Name of Supplier's End Item:	Actuator
Supplier's End Item P/N:	S213000
No. of Unique Component P/Ns in End Item:	
UTC P/N:	UTC10001
Report Prepared By:	John Smith
Telephone Number:	860-600-75
Date of Report:	
Hazardous Material:	Associated

A dialog box titled "MOC material information" is overlaid on the spreadsheet. It asks "Do you use any of the following:" and lists various materials with checkboxes for "Yes", "No", and "Maybe".

Material	Yes	No	Maybe
Metal Alloys	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Braze Fillers or Solders	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Paints/Primers or Coatings	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Adhesives or Sealants	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fire Retardants	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Solvents	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Propellants or Refrigerants	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Potting or Molding Compounds	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Lubricants or Greases	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Etchants or Strippers	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Foaming Agents	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

The dialog box also includes "Finished" and "Expert Add" buttons.

# USING FIELD EVENTS TO VALIDATE EASE OF ASSEMBLY

Microsoft Excel - HFI Event Blank.xls

File Edit View Insert Format Tools Data Window Help

100%

Security...

Arial 10

D6

	A	C	D
3	<b>HFI Category</b>	<b>Generic</b>	<b>Violations</b>
4	<b>Category 1</b> Accessibility & Ergonomics	Provide adequate clearance for installation and removal of fasteners and related torque tooling (torque wrenches, crow's feet, sockets, extensions etc). All fasteners must be capable of being torqued using standard equipment.	
5		Avoid the use of blind assembly and connections. If blind assembly cannot be avoided provide features to prevent parts from moving out of position. Provide guides to prevent tool disengagement when tool access is blind.	
6		Design modules, major assemblies, and components to allow assembly / disassembly in either a horizontal or vertical position.	
7		Label pickup and tiedown (ground handling) points.	
8		Where a unit's installation requires that its bottom surface be used as a handhold during removal or installation, a nonslip grasp type surface (e.g. grooved or frictional) shall be provided.	
9		Engine handling and support points should be free of engine or EBU external components to permit engine removal, placement of the engine on the transport stand, etc. without prior removal of external components.	
10	<b>Category 2</b> Weight/CG	Any components or assemblies exceeding 35 lbs or that are difficult to handle shall have handling provisions coordinated with the Maintainability Engineering Group and be prominently marked with weight indication and lift limitation (i.e. mechanical or two person lift). <b>OSHA Spec</b>	
11	<b>Category 3</b> Force/Torque Required	Maximum torque exceeds 1200 lb-in limit or repetitive torque application exceeds *****	
12		Bolts and nuts securing flanges shall have torque values per PWA315.	
		The preferred methods for securing threaded members are self	

HFI Generic / CSMC / TMC / EMS / CAN / MECH / SD&CI

Ready

# DRAFT HUMAN FACTORS INDEX (EXAMPLE)

Human Factors Index						
HFI Category	Design Criteria Summary	Design Score Calc	Design Score	X	Injury Wt. Factor	= HFI Category Score
<b>Category 1</b> Accessibility & Ergonomics	All Parts Directly Visable and Accessable Removal of Other Parts not Required for Access - Poor Ergonomic Positioning Limited or Eliminated	2/7 = 28%	3	X	0.12	= 0.36
<b>Category 2</b> Weight/CG	All Parts Weigh Less then 25 lbs & have Centralized CG and Limited Assembly Time Parts Weighing More Than 25 Lbs have Ground Handling Provisions.	1/1 =100%	10	X	0.16	= 1.6
<b>Category 3</b> Force/Torque	No or Low Torque Req'd. No Hammering Req'd. If Medium or High Torque, Torque/Angle of Turn Seq, or Hammering is Req'd, Repetition should be limited.	1/1 =100%	10	X	0.28	= 2.8
<b>Category 4</b> Fastener Type - QTY - Standardization	None - Press or Snap Fit, Camlock - No Harness Ties Used, Clamps Only. Low Number of Standard Fastener Sizes. Positive Retention Features, No Loose Details.	5/12 =42%	5	X	0.11	= 0.55
<b>Category5</b> Assembly Considerations	Quick Disconnect - No Tools Required - No Harness Ties Used - No Assembly Lubricant, Sealant or Burnishing of Anti-Gallant Required No Sharp Edges or Corners - Standard Hand Tools Only Required; Very Limited Safety Wiring, Heating/Cooling, or Special Assembly Tooling Reqmts	8/33 =24%	3	X	0.33	= 0.99
<b>Total HFI Score (Lower is Better)</b>						<b>HFI Total</b>
Injury Weight Factor based on Actual ITA Data.						<b>6.3</b>
Design Score Rating Guide	0% - 10% of Applicable Design Criteria Violated		1			
	10% - 20% of Applicable Design Criteria Violated		2			
	20% - 30% of Applicable Design Criteria Violated		3			
	30% - 40% of Applicable Design Criteria Violated		4			
	40% - 50% of Applicable Design Criteria Violated		5			
	50% - 60% of Applicable Design Criteria Violated		6			

# LINKING INJURY REDUCTION TO HFI: INJURY DATABASE MODIFIED

Incident Tracking and Analysis System

ITA Injury Incident Report INJ0022977 MID

What Happened | Where | Body Part | Open - Implement

Dept: SD4 2036

MAJINT: Engineering  
PRODCTR: Systems Engineering - Validation  
BUSINT: Admin

Site: MID

Responsible: PW 873161  
Supervisor/Click: Wells, Stanley L.

Equipment Id:   
Building:   
Column Number:   
Machine Type:   
Engine Model:   
Engine Assy or Part #:   
Process/Step #:   
Incident Cost \$: 0

Check all that apply:

- Ergonomic
- Equipment
- Procedure
- Training
- PPE
- Witnesses
- Comments

CAR V  
Status:

Data retrieved successfully: ITA\1468

**Changed To:**

**New Mandatory Question for Every Injury Investigation:**

**Product Design Related? Yes/No**

**If Yes, 4 More Mandatory Questions:**

**Product Model #:**

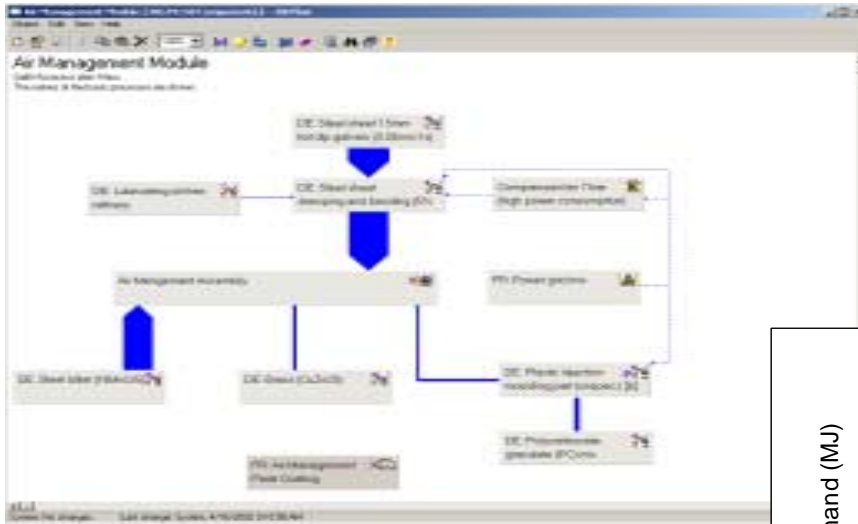
**Product Module Type: (new)**

**Product Assy or Part #:**

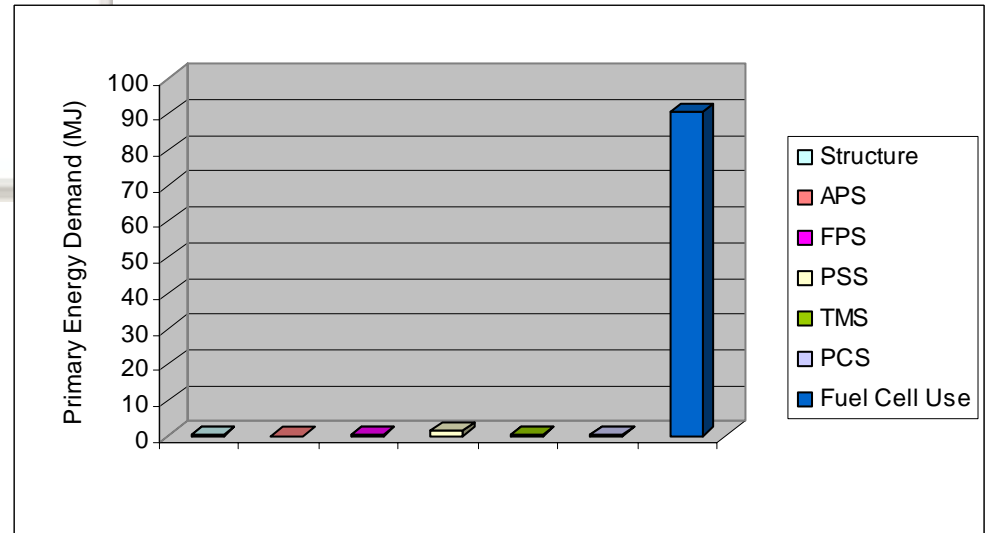
**Process/Step #:**

**If No, Above 4 Questions Are Optional**

# STRATEGIC LCA SCREENING

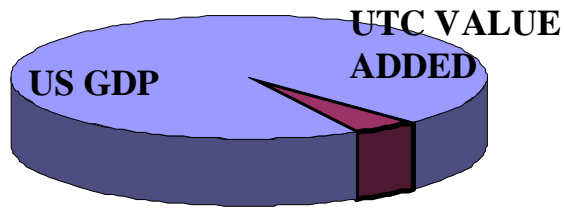


USE PHASE DOMINATES  
LIFE CYCLE IMPACT!

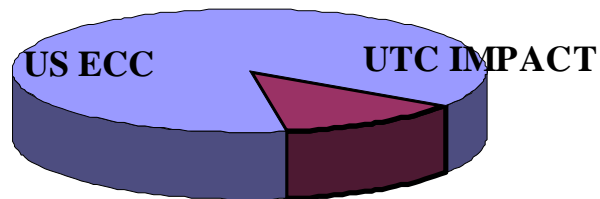


# QUANTIFIED DECISION RULES

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Sustainability Target Method



- External credibility
- Balance needs of internal design & external reporting
- NJIT
  - Sustainability Target Method
- EPFL
  - Eco-Indicator '99 metric

## Eco-indicator 99

### Applications for designers

Designers are not environmental specialists and they never will be. Still, they make decisions that influence the environment during the product's life cycle. As designers cannot consult an environmental expert in every case, they need a reliable tool to measure the environmental consequences of their design decisions. The Eco-indicator 99 is such a tool.

