ACHIEVING GLOBAL EH&S LEADERSHIP

United Technologies

INTEGRATING EHS INTO NEW PRODUCT DEVELOPMENT

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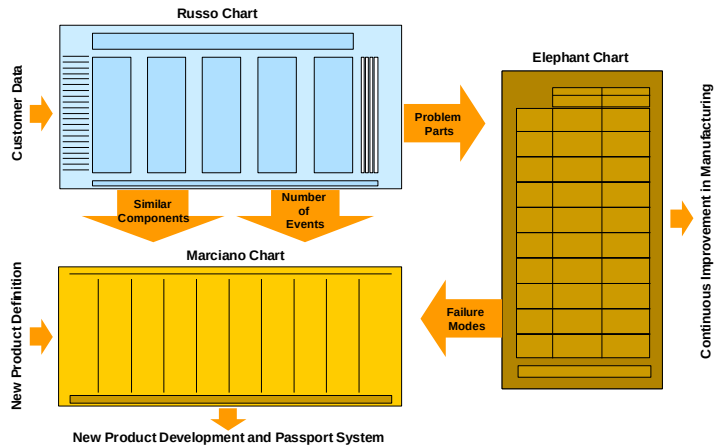
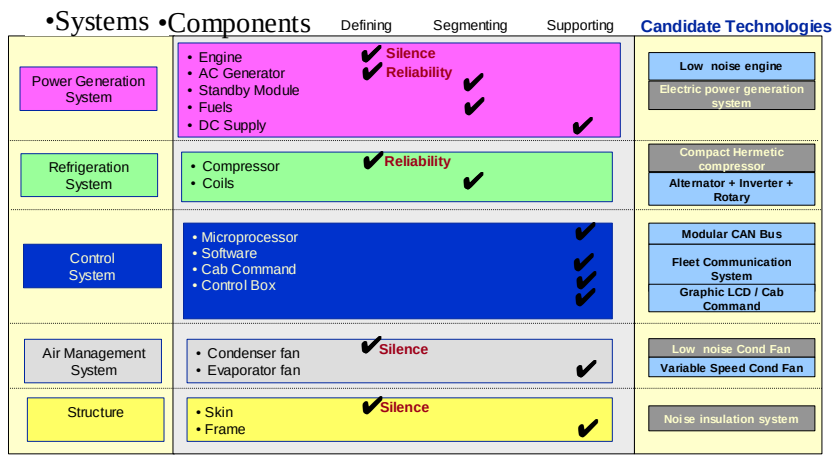
DFES ROADMAP

Integrated DFES/ DFx

Disciplined execution using Passport

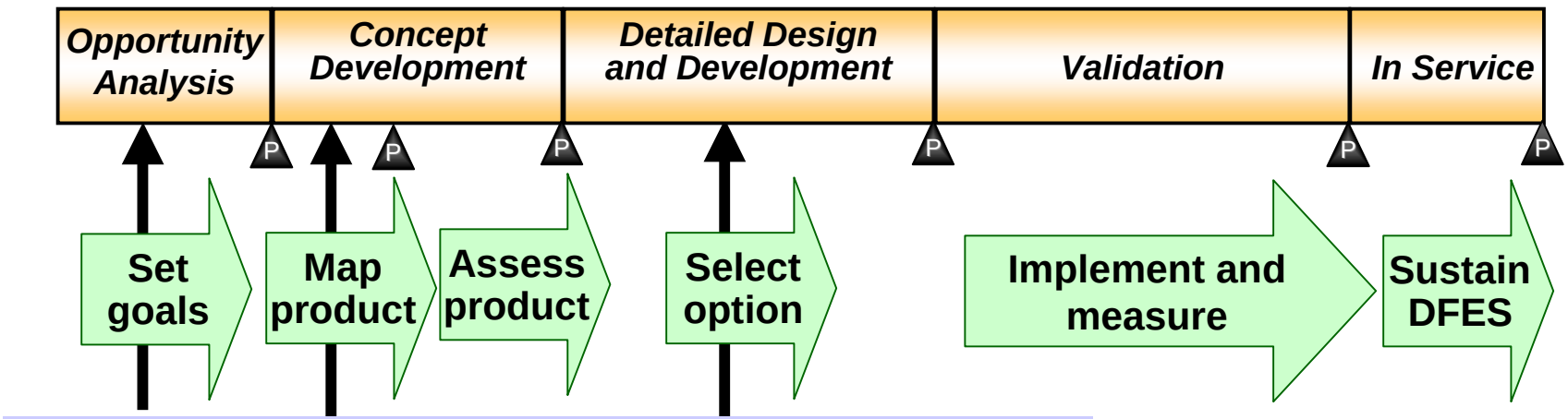


Unsatisfied stakeholder needs define innovation opportunities



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

- 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

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

•Systems	•Components
Power Generation System	• Engine • AC Generator • Standby Module • Fuels • DC Supply
Refrigeration System	• Compressor • Coils
Control System	• Software • Microprocessor • Cab Command • Control Box
Air Management System	• Condenser fan • Evaporator fan
Structure	• Skin • Frame

PRODUCT ARCHITECTURE

	A	B	C	D	E	F
1	**System**					
2		**Component**	**Material Description**	**Comp. Wt**	**System Wt.**	**Manufacturing**
3	***Cabinet & Filter***				0	
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	***Air Distribution***					
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

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?

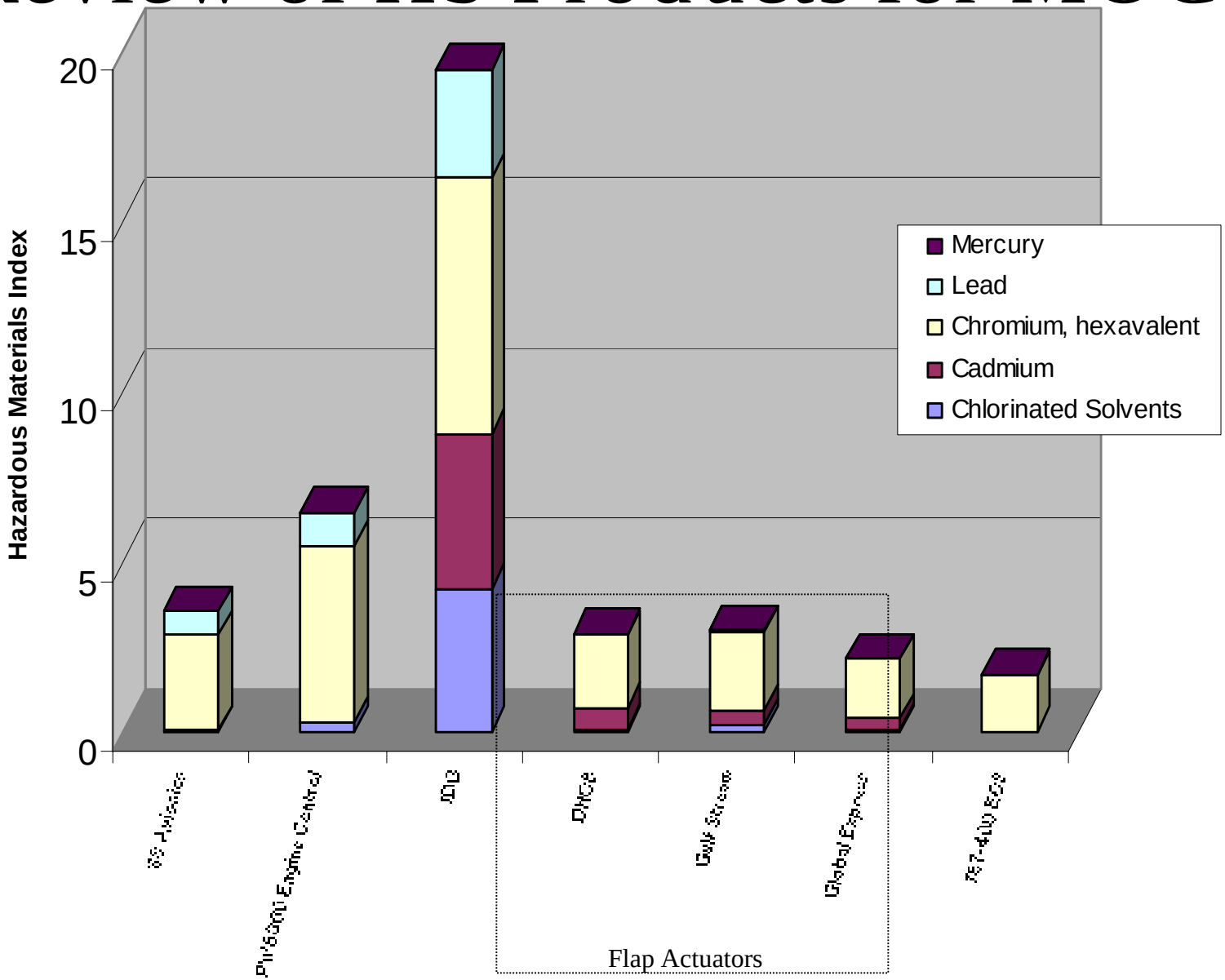
- Does expected installation/ use impose size or weight restrictions on unit?
- Do warranty costs or quality data indicate problem parts?
- Do accident data indicate problem parts for assembly or service?

VALIDATION CHECKLIST

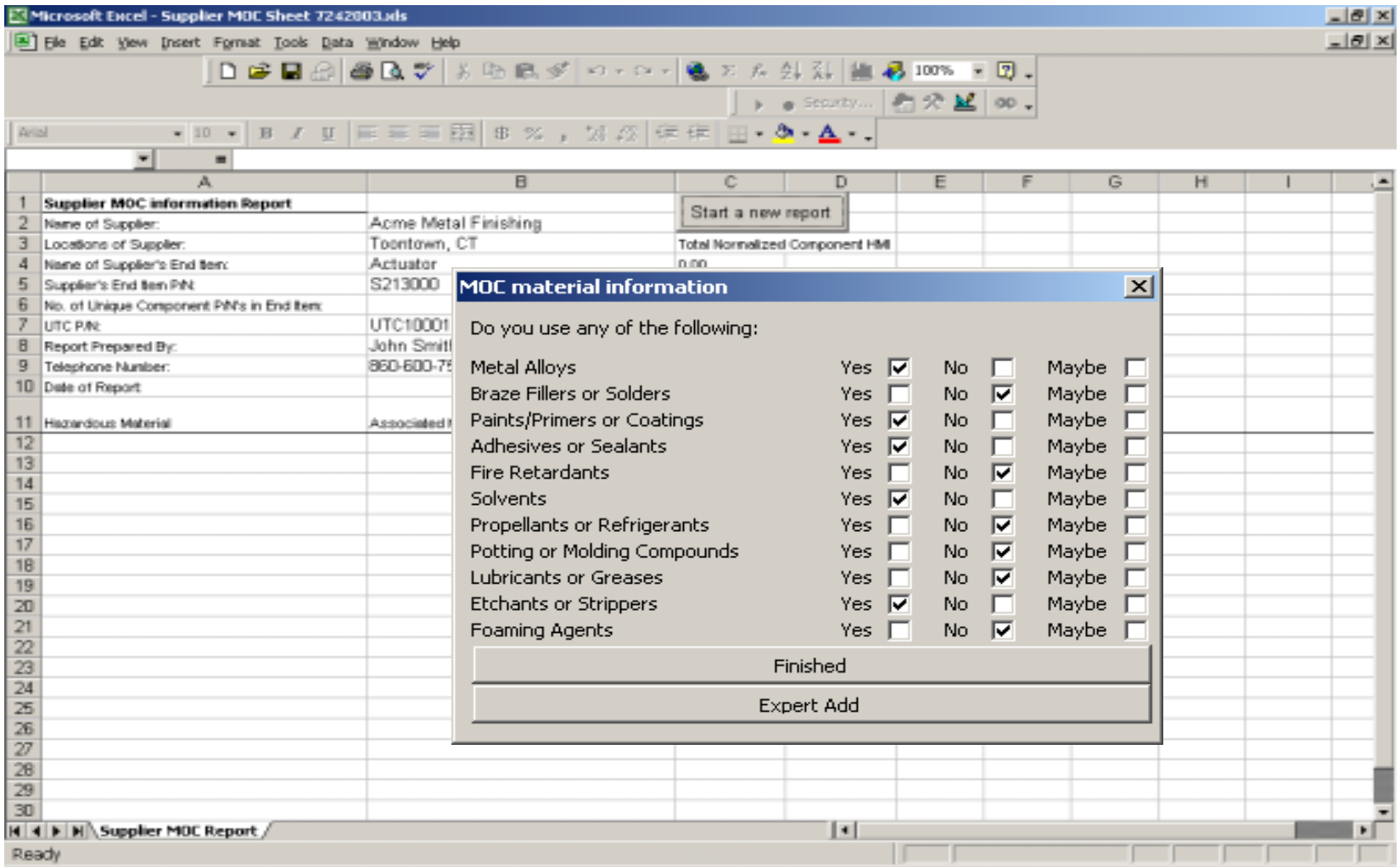
Questions linked to product environmental attribute icons

	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?
	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 =
	What is the expected total annual energy consumption for designed usage profile? What is reduction relative to reference design?
	Are all toxic materials in final product identified and accessible for removal to enable separate waste disposal treatment? HMI of final product =

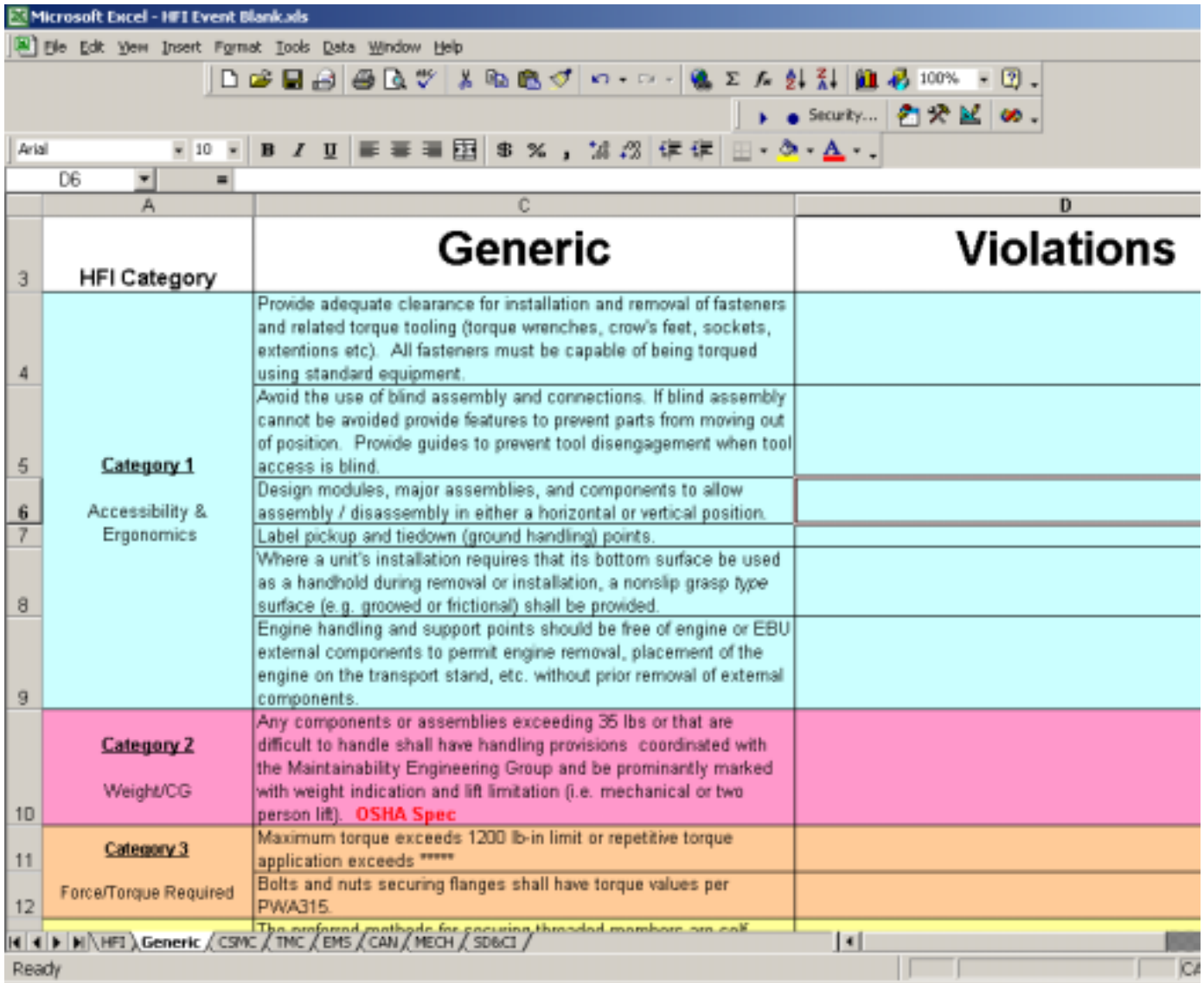
Review of HS Products for MOCs



SUPPLY CHAIN MANAGEMENT



USING FIELD EVENTS TO VALIDATE EASE OF ASSEMBLY

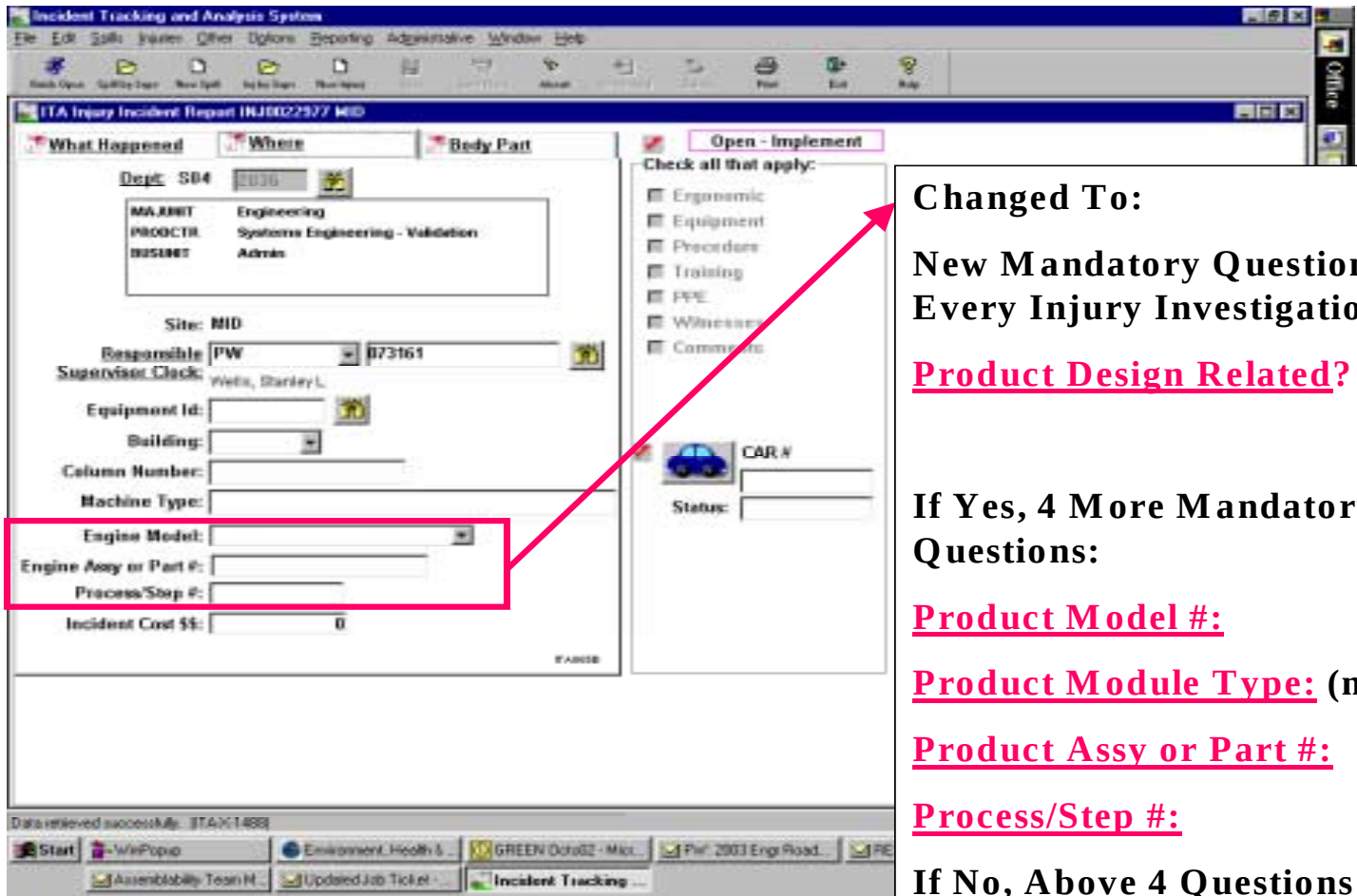


DRAFT HUMAN FACTORS INDEX (EXAMPLE)

Human Factors Index							
HFI Category	**Design Criteria Summary**	**Design Score Calc**	**Design Score**	**X**	**Injury Wt. Factor**	**=**	**HFI Category Score**
Category 1 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
Category 2 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
Category 3 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
Category 4 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
Category5 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
Total HFI Score (Lower is Better) **Injury Weight Factor based on Actual ITA Data.**							**HFI Total** **6.3**

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



Changed To:

New Mandatory Question for Every Injury Investigation:

Product Design Related? Yes/No

If Yes, 4 More Mandatory Questions:

Product Model #:

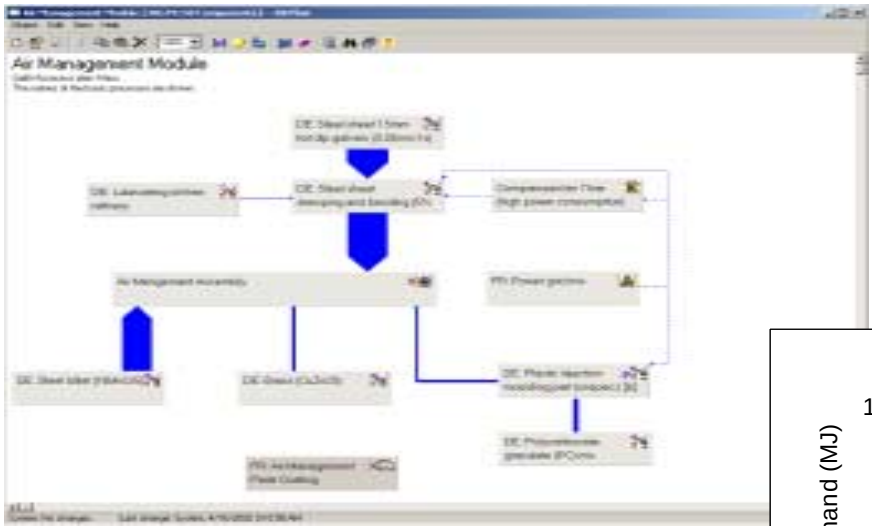
Product Module Type: (new)

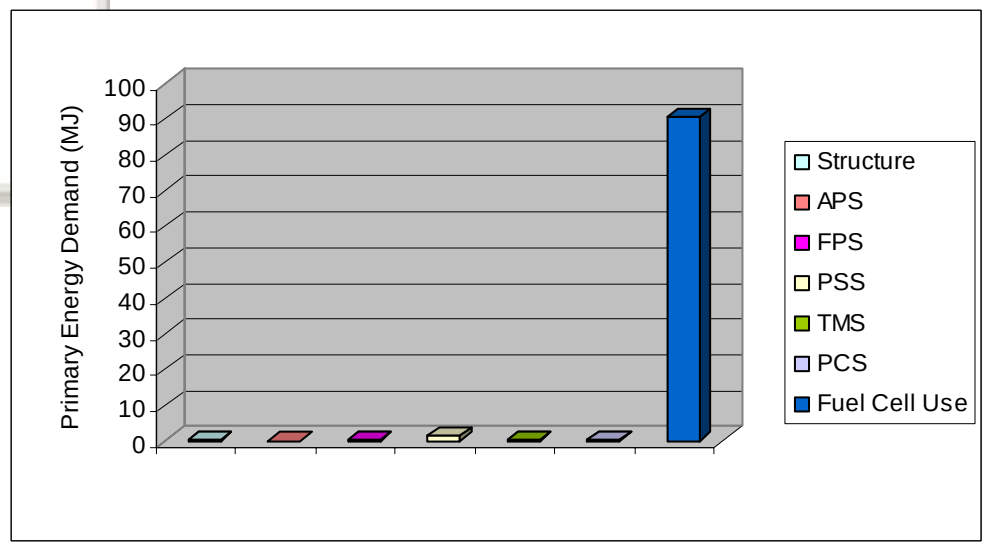
Product Assy or Part #:

Process/Step #:

If No, Above 4 Questions Are Optional

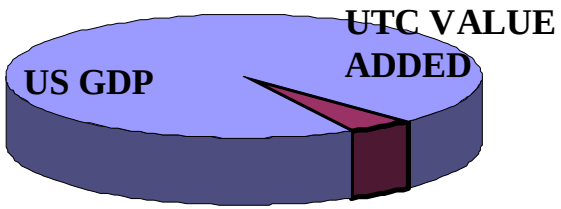
STRATEGIC LCA SCREENING



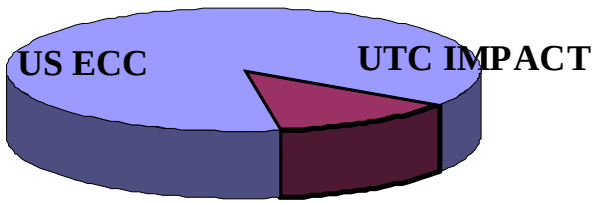


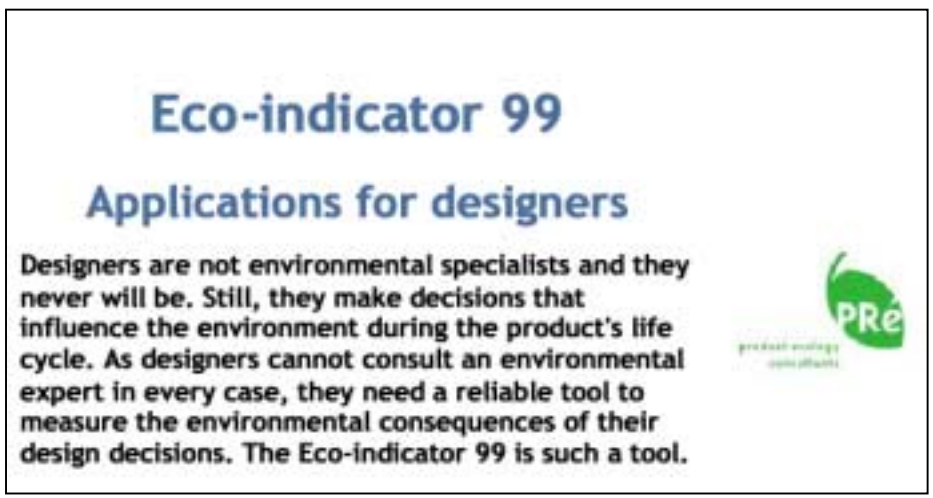
USE PHASE DOMINATES LIFE CYCLE IMPACT!

QUANTIFIED DECISION RULES



Sustainability Target Method





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