Design for environment - What, why and how at Volvo?

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Why DfE?

- Meet legal requirements
- Meet customer requirements
- Save natural recourses, lower environmental impact
- Save costs internally and for the customer
- Strengthen brand and create customer value
- Improve awareness

What is DfE?

A toolbox that can provide products and services with:

- lower environmental impact
- less resource depletion
- lower health impact

How to use DfE at Volvo?

- Environmental impact analyse (E-FMEA)
- Life cycle assessment, LCA
- Design for recycling, DRF
- Material lists (black, grey and white)
- Global Development Process, GDP
- Other helping tools

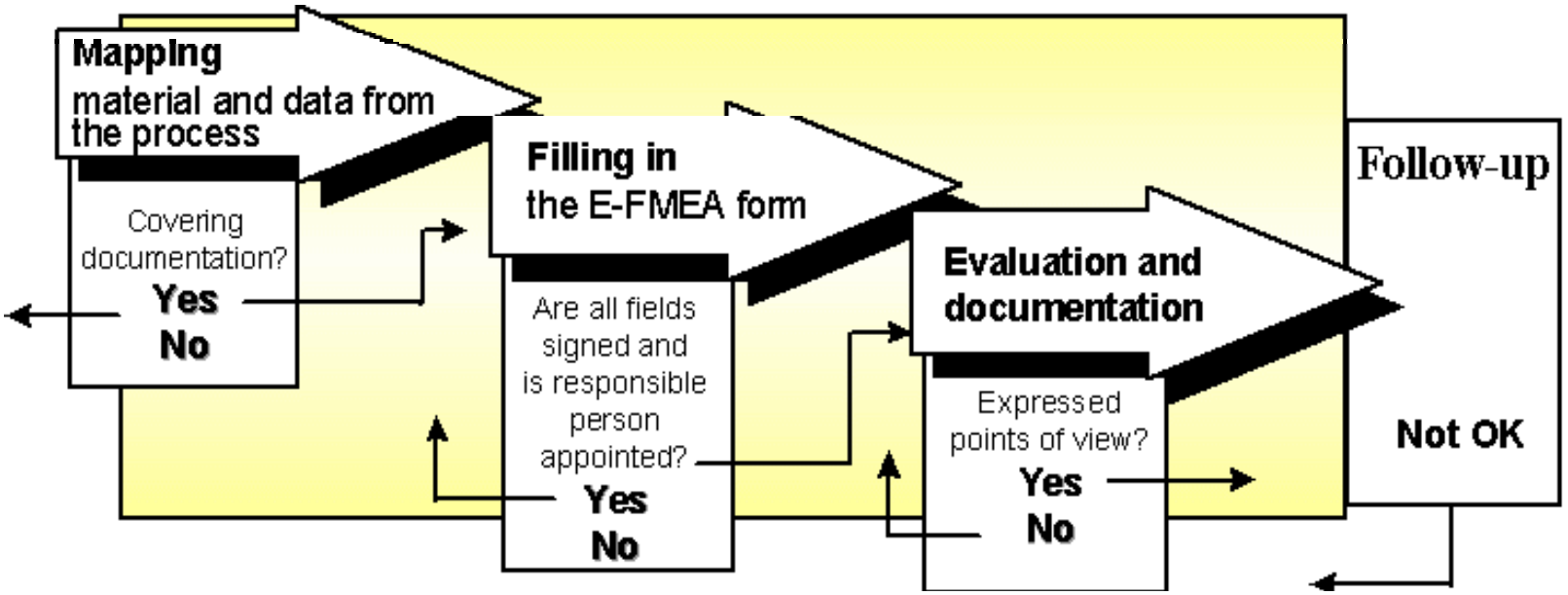
What is E-FMEA?

(Environmental impact analyse)

A method to help you:

- systematically examine internal environmental demands and legal requirements
- focus on the most important activities for environmental improvement
- establish and influence the most serious environmental aspects
- facilitate implementation of environmental conscious design

The **purpose** of the E-FMEA (*environmental impact analyse)* is to identify in time the most important environmental aspects in the product development phase in order to be able to assess and evaluate alternative materials, processes, etc.



Life Cycle Assessment, LCA

Life-cycle assessment (LCA) is a method, which has been devised to calculate the environmental impact of a product or a system.

LCA is a useful tool for choosing right materials, engineering solutions and production methods...

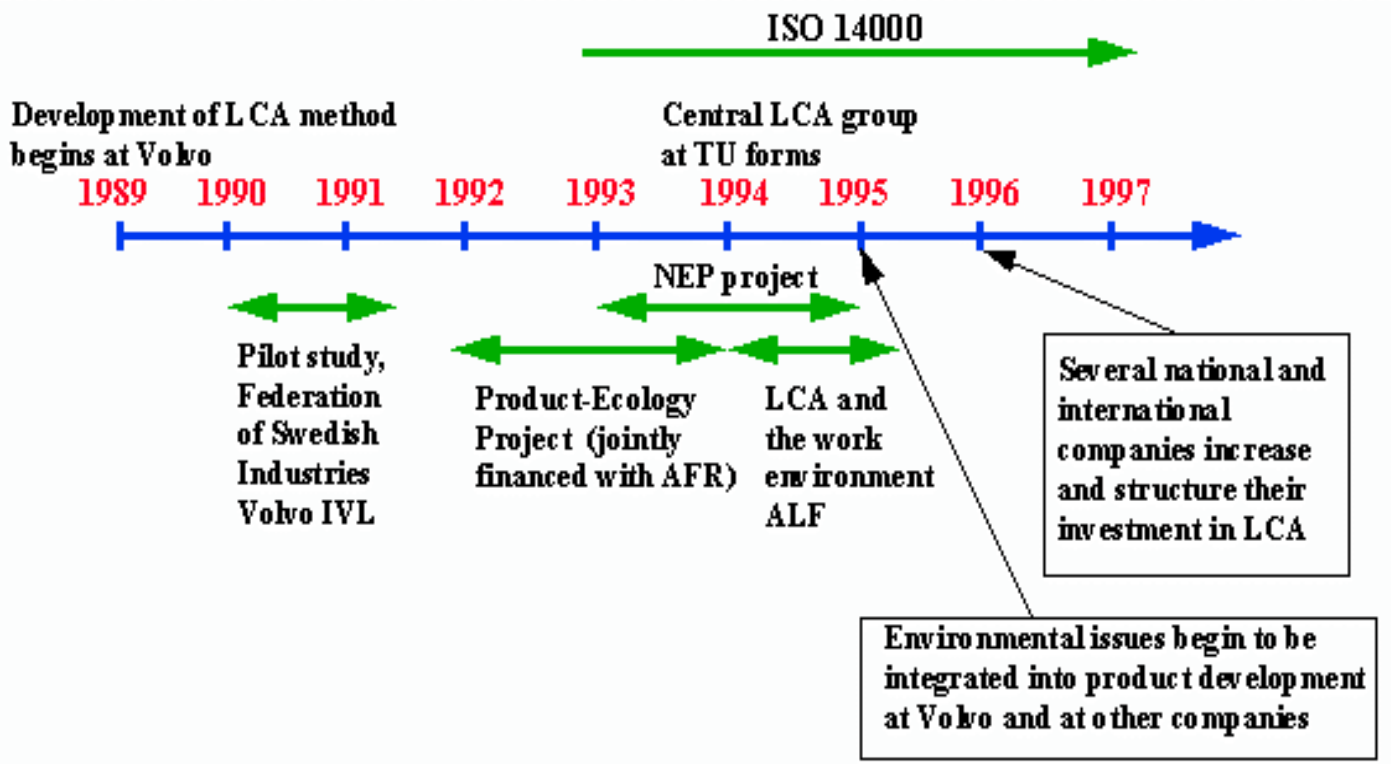
... but also an environmental indicator to find the improvements between different products.

... or as a base for an environmental product declaration, EPD

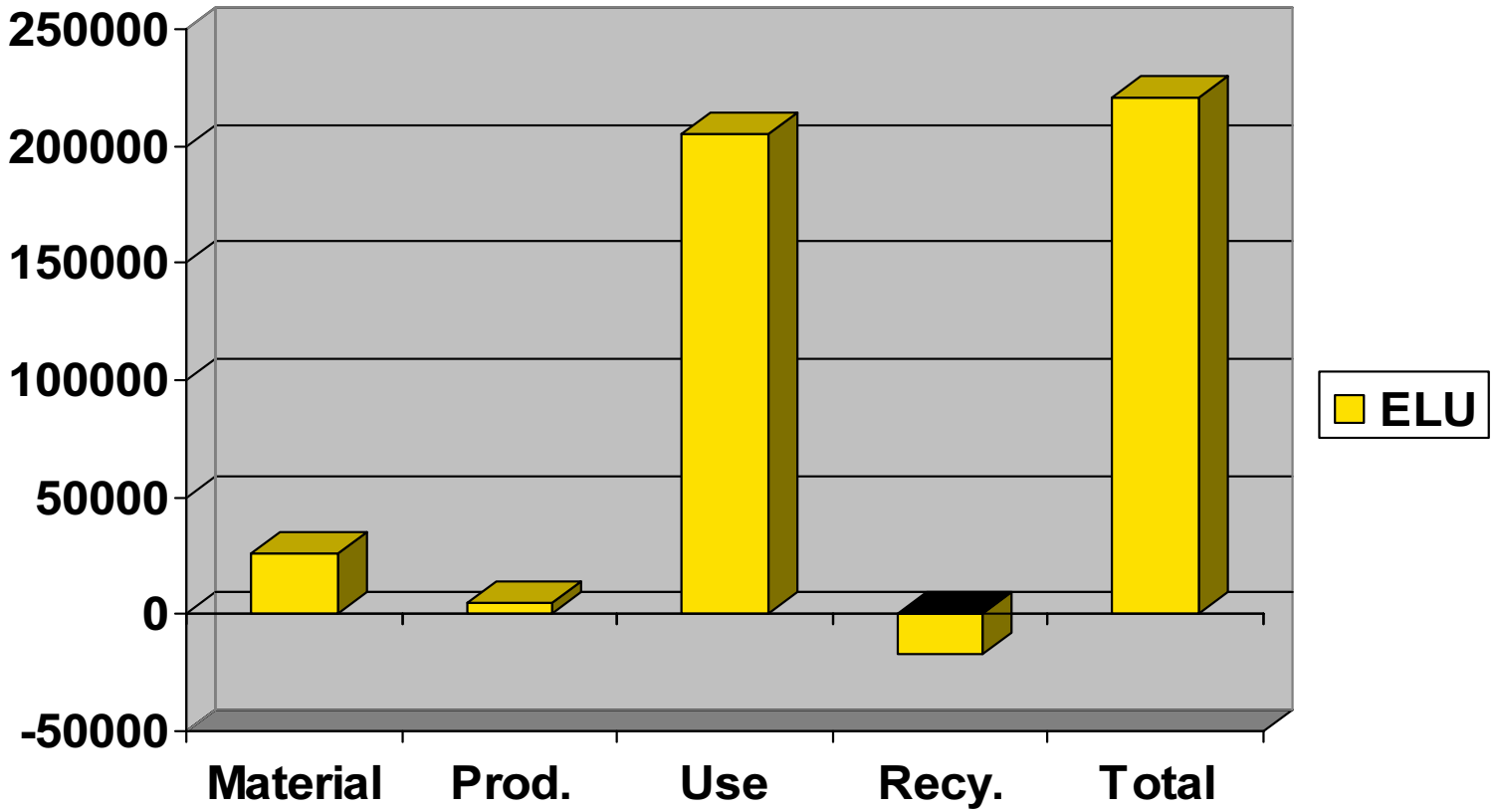
The LCA is carried out in four stages:

- **Inventory** comprising an estimate of resources, emissions and energy consumption for the complete life cycle for a product.
  (the *manufacture, useful life* and *end-of-life* process*)*
- An **analysis and evaluation** of the inventory results.
- A **assessment of the environmental problems** and which level of impact which they represent.
- An **improvement analysis**, with action proposals to reduce the overall environmental impact.

Milestones for LCA within Volvo



EPS environment load - B10L



Some inventory results from a B12M chassis

	Amount	Unit
Energy		
Electricity, Swedish means	8 074	KWh
Other energy, Swedish means	12 258	KWh
Other energi, (waste + waste heat and 12% oil)	482	KWh
Gasol	236	KWh
Diesel	20	litre
Emission air		
CO2	134	kg
HC(VOC)	360	g
Nox	600	g
SO2	40	g
PM	12	g
CFC (R11 och R12 consumption)	-	g
HCFC (R22, consumption)	13	g
Water (resources and emissions)		
Use of water (cooling excluded)	6	m^3
Use of water (cooling)	1	m^3
BOD	2	kg
COD	4	kg
Waste		
Waste, treated	878	kg
Waste, to landfill	649	kg
Hazardous waste, treated	40	kg
Hazardous waste, to landfill	23	kg

Material	Virgin material in production	Recycled material in production	End of life	Waste treatment end of life
Iron				
Nodular iron	251 kg	251 kg	502 kg	Recycled
Cast iron	35 kg	1 137 kg	1 172 kg	Recycled
Unspecified iron	7 kg	7 kg	13 kg	Recycled
Steel				
Hot-rolled steel	78 kg	O kg	78 kg	Recycled
Cold-rolled steel	276 kg	O kg	276 kg	Recycled
Stainless steel	210 kg	842 kg	980 kg	Recycled
			72 kg	Waste to landfill
Sectional steel	1 041 kg	O kg	1 041 kg	Recycled
Unspecified steel	787 kg	O kg	787 kg	Recycled
Other metals				
Aluminium	21 kg	190 kg	211 kg	Recycled
Lead	45 kg	45 kg	90 kg	Recycled
Copper	32 kg	21 kg	42 kg	Recycled
			11 kg	Waste to landfill
Brass	0 kg	2 kg	2 kg	Recycled
Plastic				
PP	4 kg	0 kg	4 kg	Waste to landfill
PA	14 kg	O kg	14 kg	Waste to landfill
PEI	65 kg	0 kg	65 kg	Waste to landfill
ABS	6 kg	0 kg	6 kg	Waste to landfill
PVC	13 kg	0 kg	13 kg	Waste to landfill
Other materials				
Rubber	414 kg	O kg	385 kg	Energy extraction
			29 kg	Waste to landfill
Paint	15-18 l	0 kg	15-18 litre	Waste to landfill
Oil/Grease	37 l	0 kg	37 litre	Hazardous waste treated
Sulphuric acid	34 kg	0 kg	34 kg	Hazardous waste treated
Wood	5 kg	0 kg	5 kg	Waste to landfill
Others	93 kg	0 kg	93 kg	Waste to landfill

Design for Recycling (DRF), some guidelines ...

- Avoid hazardous materials and substances (Volvo black and grey lists)
- Limit the number of different materials
- Use recycled materials
- Mark plastic components with marks easy to read and find
- Minimise surface treatment of plastics. Colour impregnation of plastic is a better alternative or use surface material that is compatible with bearer material
- Use glue/tape/labels that are compatible with bearer material
- Use few attachment elements that is easy to remove or made in a uniform material

The Volvo Material Lists

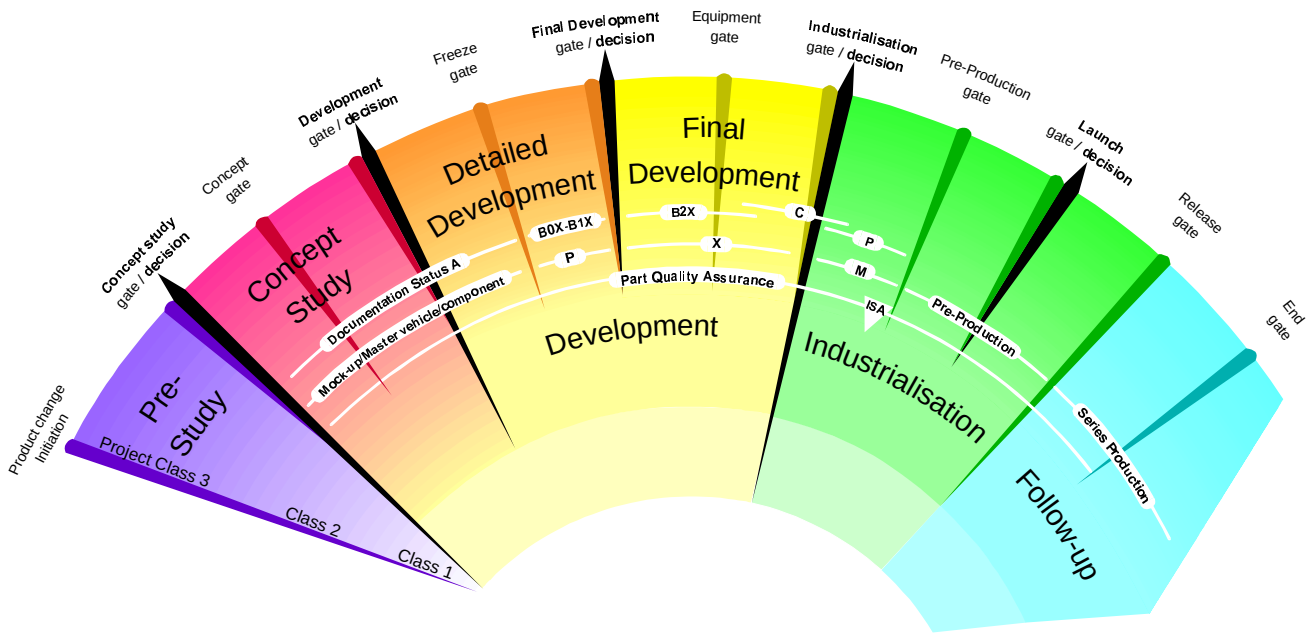
Black list: Chemical substances not be used within the Volvo Group

Grey list: Chemical substances that should be avoided within the Volvo Group

White list: Substitutes for hazardous chemical substances

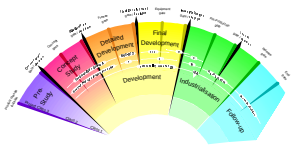
Group	Substance name	CAS no. 1)	KEMI–listed	Example of type or area of use	Risk 2)
Amines	Phenyl-b-naphthylamine	135-88-6	R	Antioxidant	C
	Methylenedianiline (4,4'-) (MDA)	101-77-9	R, O	Hardener, in paints	C
Fibres	Asbestos	Several	R	Insulating material	C

Global Development Process, GDP

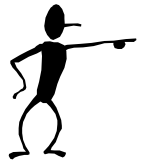


...is the model for how all product development projects within Volvo Trucks and Volvo Bus are performed.

The environmental requirement in GPD



- Concept gate: Draw up time schedule for E-FMEA / LCA
- Development gate: Conduct E-FMEA and LCA according to plan. Draw up time schedule for DRF analyst (Design for Recycling)
- Final Development Gate: Ensure the use of black and grey list. Draw up time schedule for screening LCA and follow up earlier environmental activities (LCA, E-FMEA and DFR)
- Industrialisation gate: Follow up Screening LCA and DRF. Finalise data for the EPD
- Launch gate: Ensure that the Black and Grey list are verified. Complete data for a disassembly manual



A few general guidelines for environmental design in vehicle industry

- Select materials with low weight
- Use materials easy to recycle
- Avoid substances that are hazardous to nature and/or health
- Reduce fuel consumption (ex. reduce air drag and rolling resistance)
- Capacity requirement should dictate actual capacity
- Use a thermoelast rubber material in favour of a thermoset elast

Other tools to help ...

- Environmental guidelines for engineers - manual
- Environmental education
- MOTIV - a database of chemicals used at Volvo and VCC
- A lot of persistence …

Ongoing activity at Volvo Buses/Volvo

- EPD for a new complete bus
- Participation in Omnitox, EU-project
- Upgrade of fuel LCA database
- Upgrade of propulsion LCA database
- Increased use of LCA in Advanced Engineering