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## HOW TO USE LCA TO ASSESS MATERIALS AS ECO-DESIGN PARAMETERS IN CONSTRUCTION PROJECTS?

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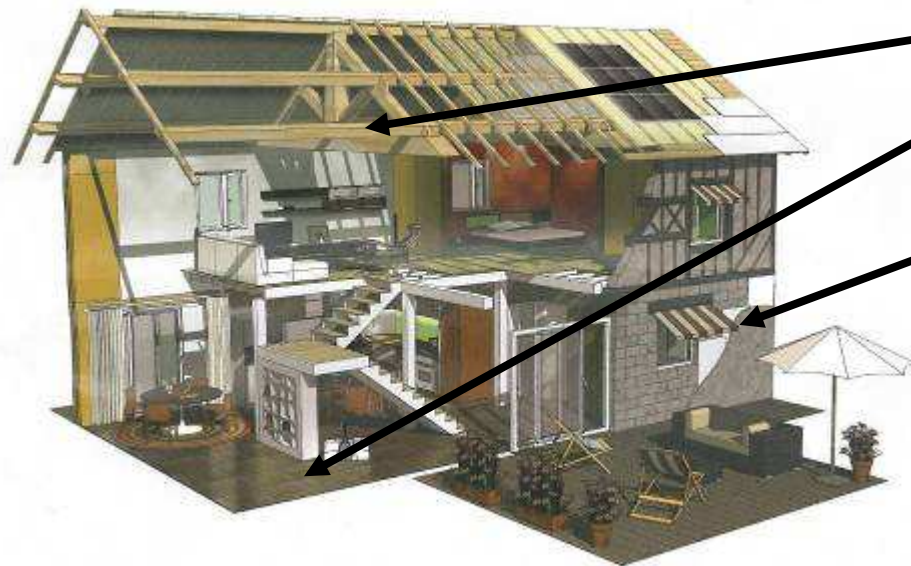


# Context

- Eco-design:
- Designing a product considering its environmental performances
  - Adding environmental functionalities to a product



Ex: Using so-called « green materials »



i.e. bio-sourced materials

i.e. depolluting materials  
(TiO<sub>2</sub>)



LCA is the appropriate method to quantify environmental performances of technological solutions



Can LCA of materials evaluate and compare their environmental performances inside a construction ?

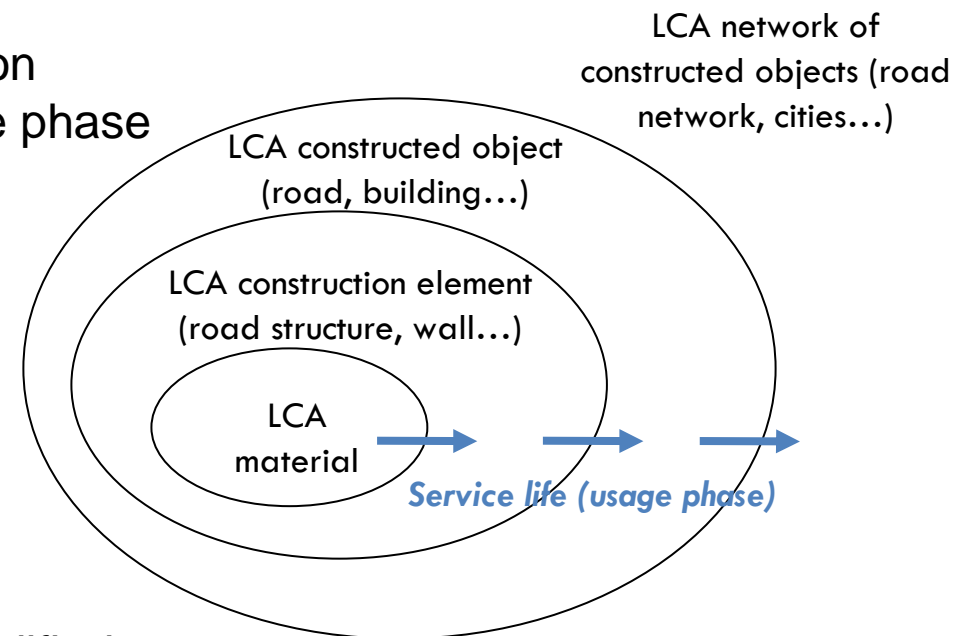
# Problematic

➔ Comparing construction materials with LCA requires to define a Functional Unit (FU)

➔ Construction materials can be (are!) multi-fonctionnal



➔ In construction, considering a function implies to change scale at the usage phase (nested scales)



➔ In construction, functions can be modified (altered/improved) with time

# Objectives

Give an overview of:

- ➔ Correspondance between functions:  
in general, in eco-design and in LCA
- ➔ Defining types of functions
  - ➔ Levels of LCA complexity according to  
types of functions occupied by materials
  - ➔ Help to identify knowledge needs
  - ➔ Highlight research perspectives

## Defining functions: the general meaning

*Generic definition of the word “function”*

*Literally: “the **role** of an element in an **ensemble**”*

The type of a function requires to define:

→ the role itself

→ the ensemble inside which the role is played

# Defining functions: the « fuon\* » concept in eco-design

What is a fuon?  A list of functions that can be of different natures:

- Physical magnitudes:** they have physical units. They imply restrictions in the technology or physical implementations that the product can have.
- Scalable subjective constraints:** they can take a value out of a subjective scale—such as 1–9, for example, which can be particularly useful in qualitative evaluations. *Examples of this are hygienic or ergonomic constraints.*
- Classifications or selections from a set of options,** with a limited subset of answers. *Examples of this are types of energy (used or produced).*
- Requirements as dichotomies:** they set a constraint for something that has to be accomplished in the design, and are modeled as a Boolean variable (true/false). *Examples of this are requirements for transparency.*

Authors distinguish « main » and « secondary » functions

Main functions are generally of physical magnitude nature

\*Collado-Ruiz D., Ostad-Ahmad-Ghorabi H. 2010. Fuon theory: standardizing functional units for product design. *Resources, conservation and recycling* 54:683-691

# Defining functions: considering the ensemble (nested scales)

**environment**

**constructed object  
(building, infrastructure)**

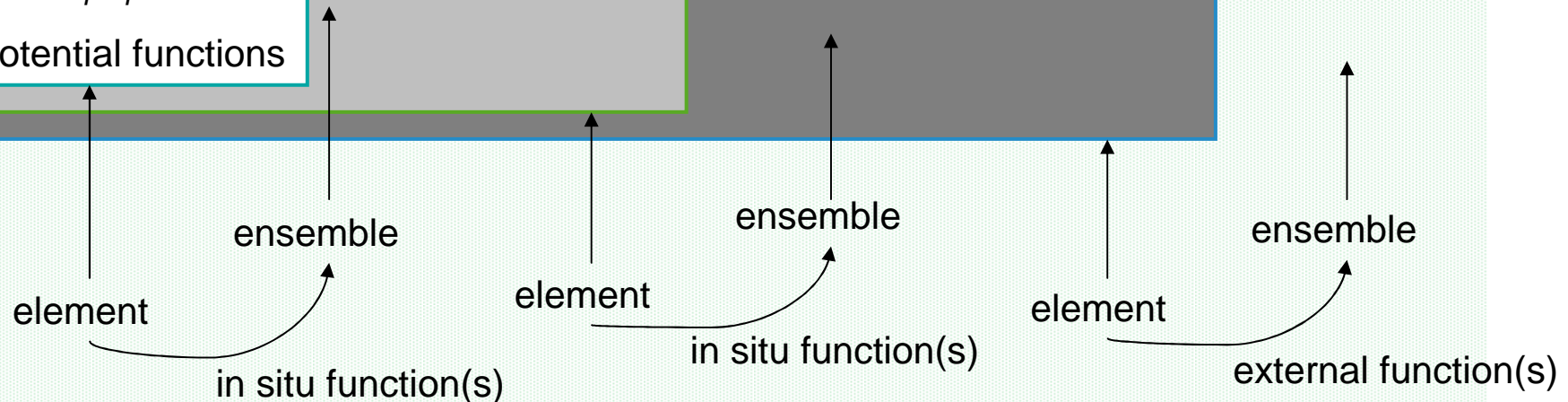
Assembly of construction elements

**construction element**

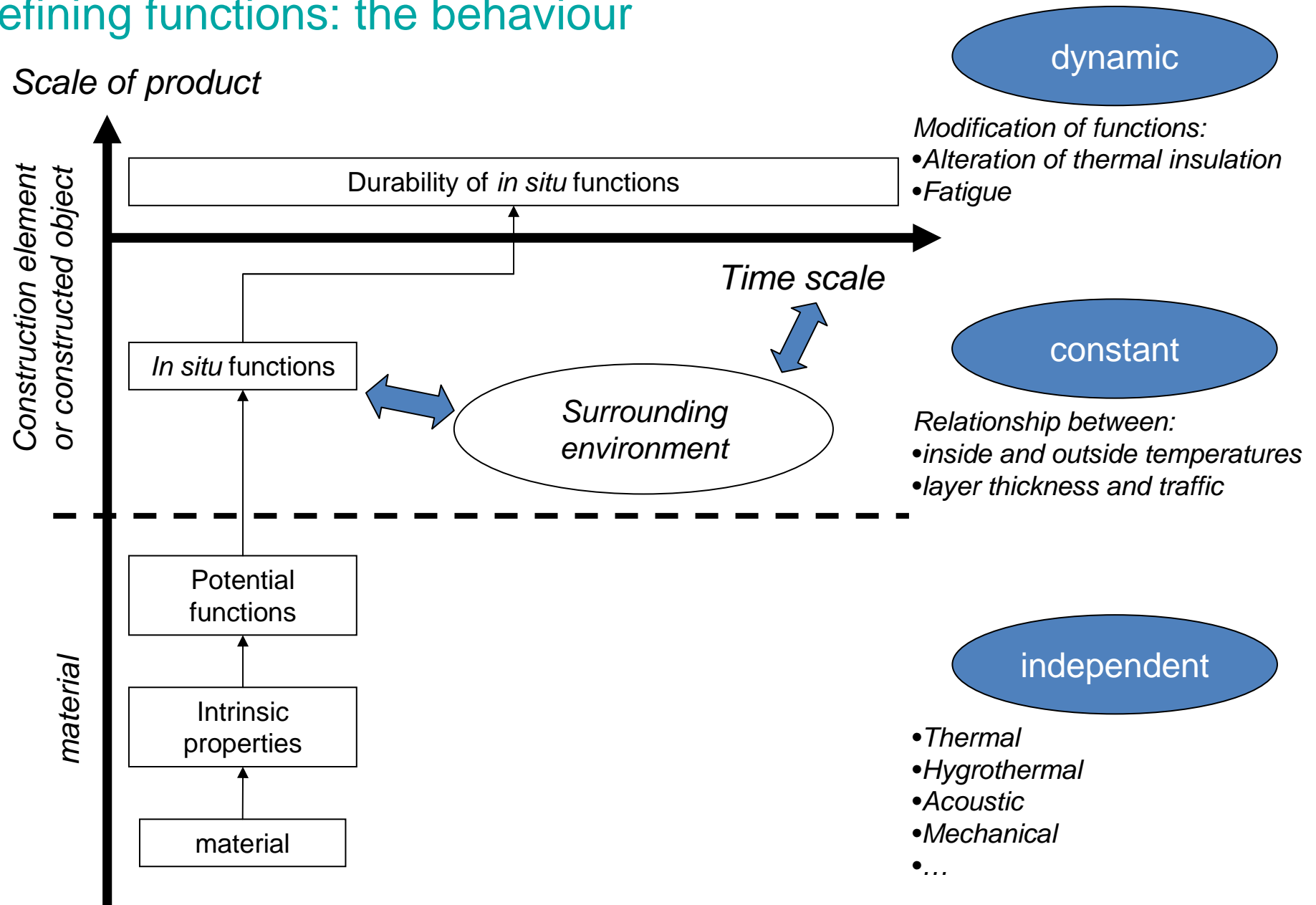
Assembly of materials

**material**

*Intrinsic properties:*  
potential functions



# Defining functions: the behaviour





# Defining functions: synthesis of characteristics

## The function of a product can be characterized by

- a **stake issue** which corresponds to the “ensemble inside which the role is played”.

Two categories of functions can be identified according to their stakes:

- **technological functions**: meets stakes that are exclusively related to quantifiable physical characteristics of the studied product: modifying the value of a function will necessarily modify the physical characteristics of the product

→ Scales concerned: material, construction element, constructed object

- **external functions**: their values can not be controlled by modifications on the studied product (i.e. environmental functions are not considered in LCA because they are assessed by the LCA method, landscape function...)

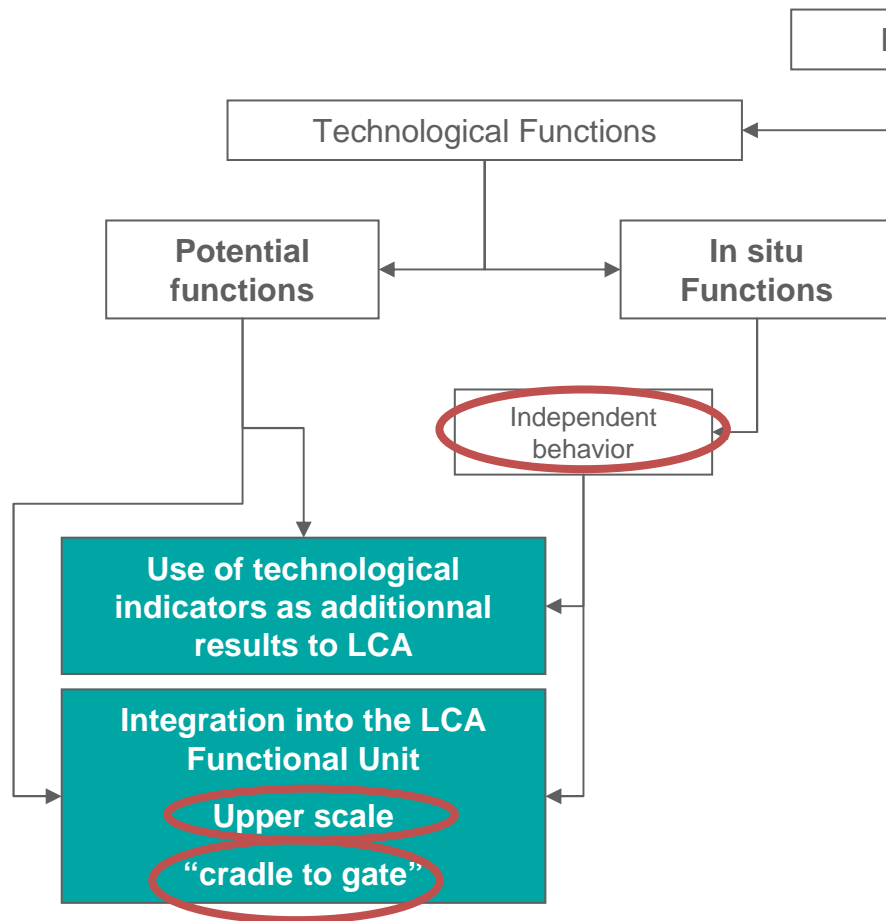
→ Scales concerned: natural or built environment (outside the constructed object), economic market, society

- a set of **values** (function) relative to main and secondary “roles”

- a **behaviour** for each value, that can be:

- **independent** of the surrounding environment
- **constant** if the value depends on the environment but not variable with time
- **dynamic** if the value depends on the environment and is variable with time

# Can all functions be in the functional unit?



➔ FU: not a comparison of materials  
 Comparison of functions: same role, same ensemble

## materials

**Concrete block**



**Wood panel**



Potential functions

•Bearing capacity

•Bearing capacity  
 •Thermal resistance

*FU: same bearing capacity (main fonction)  
 Thermal resistance as an additionnal information*

**Construction element (wall)**

**Concrete block + insulation material**



**Wood panel**

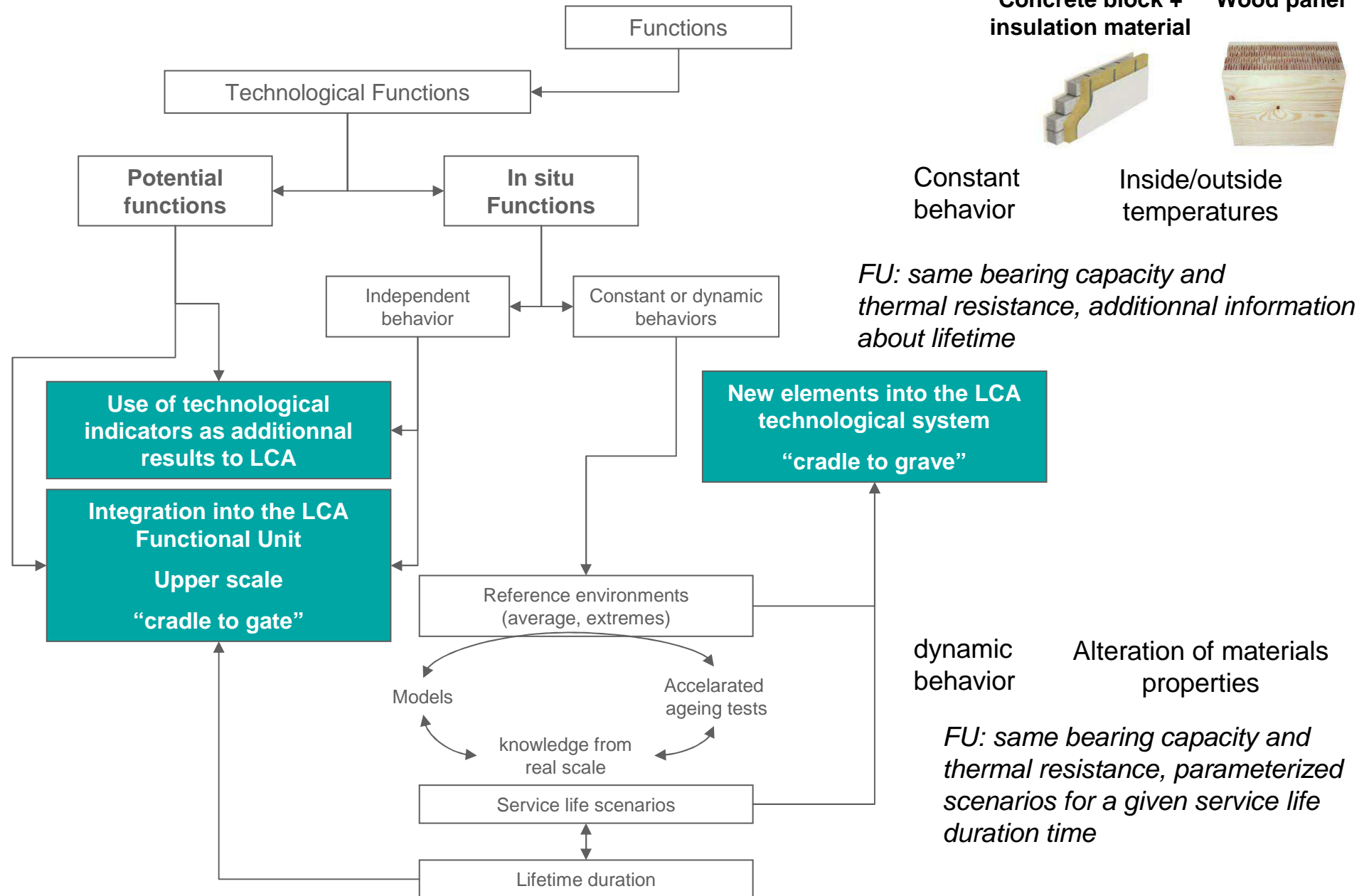


In situ functions

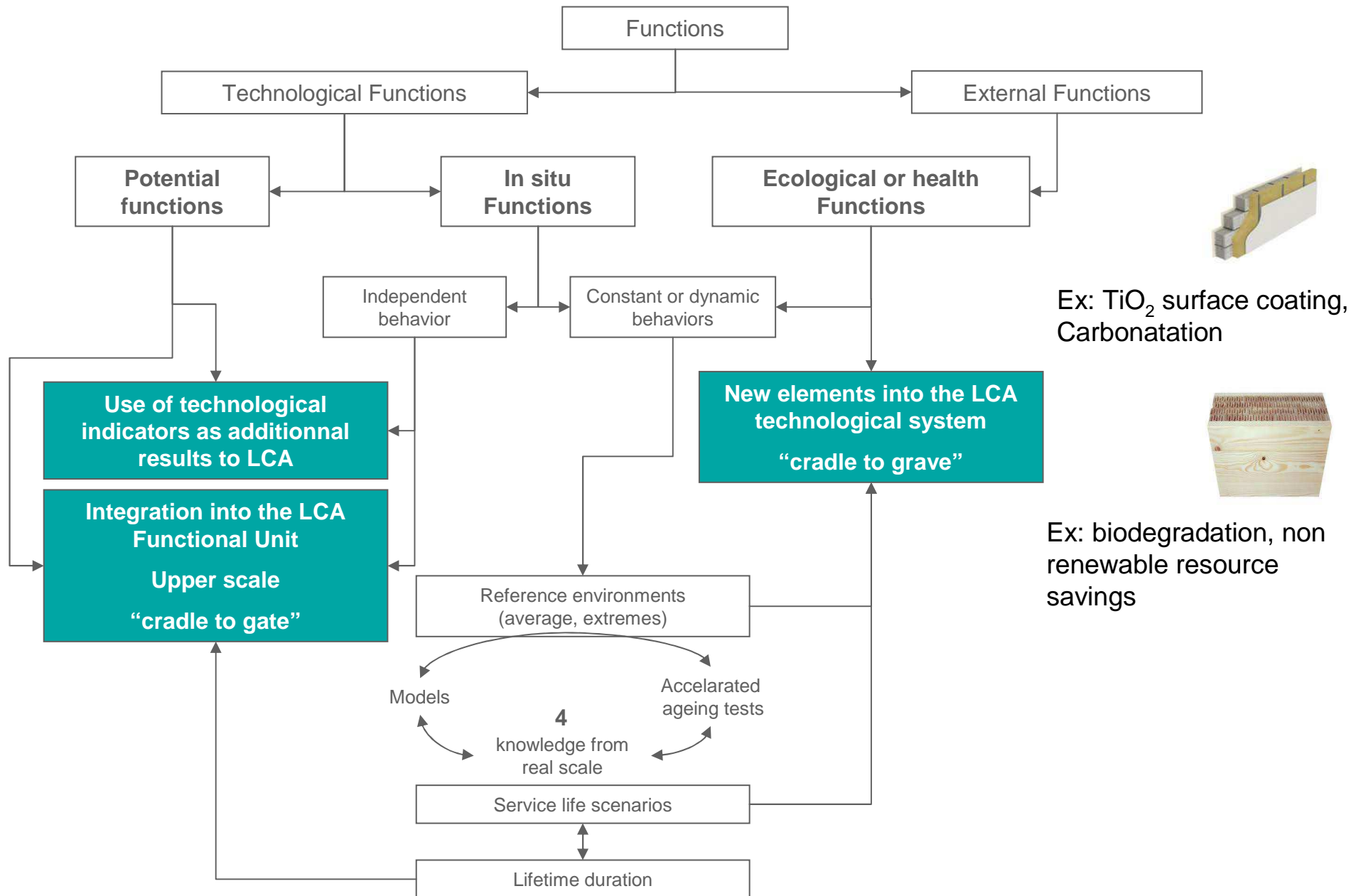
•Bearing capacity  
 •Thermal resistance

*FU: same bearing capacity and thermal resistance (2 main fonctions)*

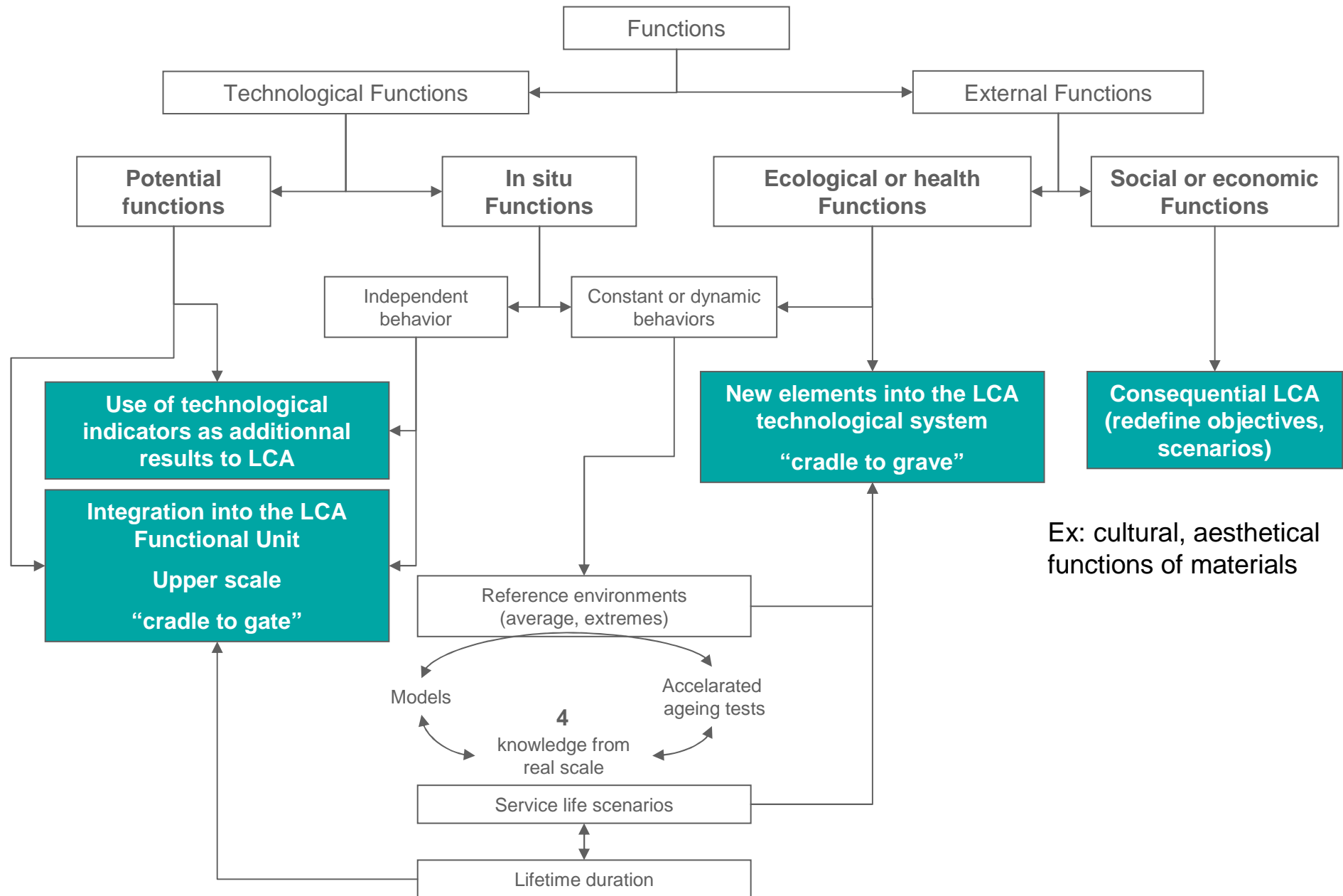
# Can all functions be in the functional unit?



# Can all functions be in the functional unit?



# Can all functions be in the functional unit?



# Conclusion

➔ How to compare materials with LCA if they play different roles in different ensembles ?

➔ All Eco-design functions can not be included in the functional unit in LCA

They can be integrated by changes in the system, by redefining the objectives or by using scenarios

➔ Different levels of LCA complexity according to types of functions considered in the study

Iterative approach

The upper the function scale, the greater the LCA complexit

➔ Help to identify knowledge needs

Interactions between functions and the environment, their durability

➔ Highlight research perspectives

Relationships between functions at different scales: could the “fuon” concept be appropriate (nested “fuons”)?

Thanks for your attention