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GUIDELINE DEVELOPMENT TO DESIGN MODULAR PRODUCTS

THAT MEET THE NEEDS OF CIRCULAR ECONOMY

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Profit due to product sales

- Products are disposed at end of life leading to high amount of electronic waste
- Most devices are still functioning or contain components and parts which are still working
- High number of old devices at home no incentives to bring back products





Aiming at Circular Economy

- Goal: keep value of product as long and as high as possible
- With a modular product structure we enable Repair, Reuse, Remanufacturing and Recycling
- Modularity is an essential requirement!



CE-Strategies



Modularity - Status Quo

Parts and components are grouped in independent elements or subassemblies, connected via interfaces.



Aim: to simplify manufacturing and assembly but also development, product design



Modularity - New Approach

Parts and components are grouped in independent elements or subassemblies according to their end of life strategies, connected via standardised interfaces.

Design for Repair	⇒ Failure on product level
Design for Reuse	⇒ used memory, camera
Design for Remanufacturing	⇒ Printed circuit board
Design for Recycling	⇒ broken display, weak battery



Guideline to achieve modular products

- Target products: electronics, especially smart mobile devices
- For each step we ask questions, suggest web-tools and methods to support decision making





CASE STUDY SPEECH PROCESSING SOLUTIONS



DIGITAL VOICE RECORDER

Product:	Philips DPM 8000
Function:	Voice recording 4h hours/daily
Use time:	4 years in average
Life time:	> 4 years (except battery)

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1) Defining the product's CE-Strategy

How to keep the value of the product?

Which CE strategy (Repair, Reuse, Remanufacturing and Recycling) fits best?



Guiding Questions:

- What is the relevant life-cycle-phase?
- What is the lifetime product vs. use time?
- Does the product contain valuable parts?
- Is there a chance to establish take-back possibilities?





2) Developing a new Business Model

Support the CE-design by a appropriate Business Model:

- Keep control over the resources (leasing, sharing, pay per use, etc.)
- Realise new revenues through additional services or spare products
- Preserve the value through take back (reverse logistics...)





if product needs to be refurbished,
repaired or updated



3) Defining the CE-Strategies of subassemblies and parts

Investigate on a component level: Which strategy is relevant?



- Those with the highest value should be kept
- Detect failure parts to be changed during use (FMEA)
- Other properties of parts to be considered: function, interfaces, lifetime vs. lifetime of product,

3) Defining the CE-Strategies of subassemblies and parts

Components that can be used only once for various reasons: "**Design for Recycling**".

Components that can be used in the same type of product and even in the updated product: "**Design for Reuse**".

Valuable components that needs to be changed for a reuse in the updated product: "**Design for Remanufacturing**".





4) Defining the Modules

Cluster Parts and Subassemblies with similar Properties:

- must: same end-of-life strategy
- should: similar expected life time



 technical feasible, combine similar functions, think of possible second life, same recycling process needed, etc.





5) Designing the Modules

Create the module's technical structure

Finding design aspects

- Specification sheetLegislation
- D4R Checklists

Dfx

No.	Category	D4R-Criteria	
1	erials	Recyclability of materials	Gl
2	Structure Mate	Suitability of material combination for recycling (Simi	ç
7		Modularity of the structure	•
8		Accessibility of battery	C
9		Separation of electronic components	s r
10		Upgradeability of the product	• \
11	10.1	Upgradeability for future firmware	

Guiding questions:

- Focus on different design guidelines – D4R
- How are the modules connected to each other? Can a easy, nondestructive separation of the modules be realised?
- Which interfaces are needed?

5) Designing the Modules

- Additional requirements were defined which result from the modularisation
- Additional interfaces between modules were specified
- Detachable joints and connectors were used







SUMMARY

- To fully exploit the circularity potential of a product different CE-strategies have to be considered within a product.
- A guideline has been developed which helps to systematically realise D4R-Modularity that allow Circular Economy.
- The Case Study including the D4R-Modularity and a matching business model shows a positive environmental impact.



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Thank you

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