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Design for change and circularity – accommodating circular material & product flows in construction

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Abstract

Circular building concepts, as proposed within e.g. Circular Economy and Cradle-to-Cradle frameworks, imply radical changes for the construction sector. Cradle-to-Cradle® in particular has put forward the idea of buildings as *material banks*, radically altering the way material flows need to be managed. The notion of material banks (temporary storage of materials that comprise the building assemblies) sheds new light on the value of building materials and products, and how to maintain and restore this. The basics are straightforward: high quality, pure material use and anticipated material regeneration routes. The implications for the supply and value chain, however, are significant, and research in this direction has only recently taken off. To smoothen the path to implementation, circular building principles may be combined with Design-for-Adaptability (DfA) guidelines, as developed over the last decades. DfA guidelines are rooted in enhanced resilience of the built environment on the one hand, and the associated constructive implications on the other. Synergy between the concepts of *circularity* and *adaptability*, with regard to the Dutch context, is at the heart of this paper. The main research question is: what are prerequisites for an effective performance of materials, products, services and buildings in the case circularity is a leading ambition? The research is structured around four interdisciplinary expert workshops in which knowledge and experiences were shared, discussed, tested and redefined, leading to a set of preconditions for circular building material and product flows. A key finding is that circularity-values emerge at the intersection of specific *intrinsic properties* (material and product characteristics) and *relational properties* (building design and use characteristics), whilst combining multiple parameters. In separation, neither intrinsic nor relational properties have decisive significance with regard to circularity; it is on the crossing where fulfillment is created. This paper finishes by discussing the findings from the perspectives of lifespan, monitoring, ownership, and standardization.

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Keywords: Circular Economy; Design for Adaptability; Cradle to Cradle; Open Building, Integrated Sustainability

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1. Introduction: Circular material flows & Flexible buildings

1.1. Circular material flows

In the light of large global and local challenges relating, amongst others, resource scarcity, the European Union shows a shift in focus from linear to circular systems, whilst regarding waste as a resource [1]. Not only offers a circular approach an escape from depleting and wasting valuable resources, it is also linked to reduced dependencies on other countries for the supply of resources and to the creation of jobs [1,2,3]. However, circular resource flow systems usually imply higher levels of complexity, due to large changes in the way actors are interconnected, be it related to water, materials, top-soil for food production or energy systems [4]. For example, regarding decentralized decision-making, extended producer responsibility and reverse logistics. So far, many envisioned design solutions for the implementation of circular material flows have fallen short due to their relatively one-sided nature i.e. being too technocratic and too static, taking insufficient account of how environmental, social, technical, economic and temporal factors are integrated in practice [5,6].

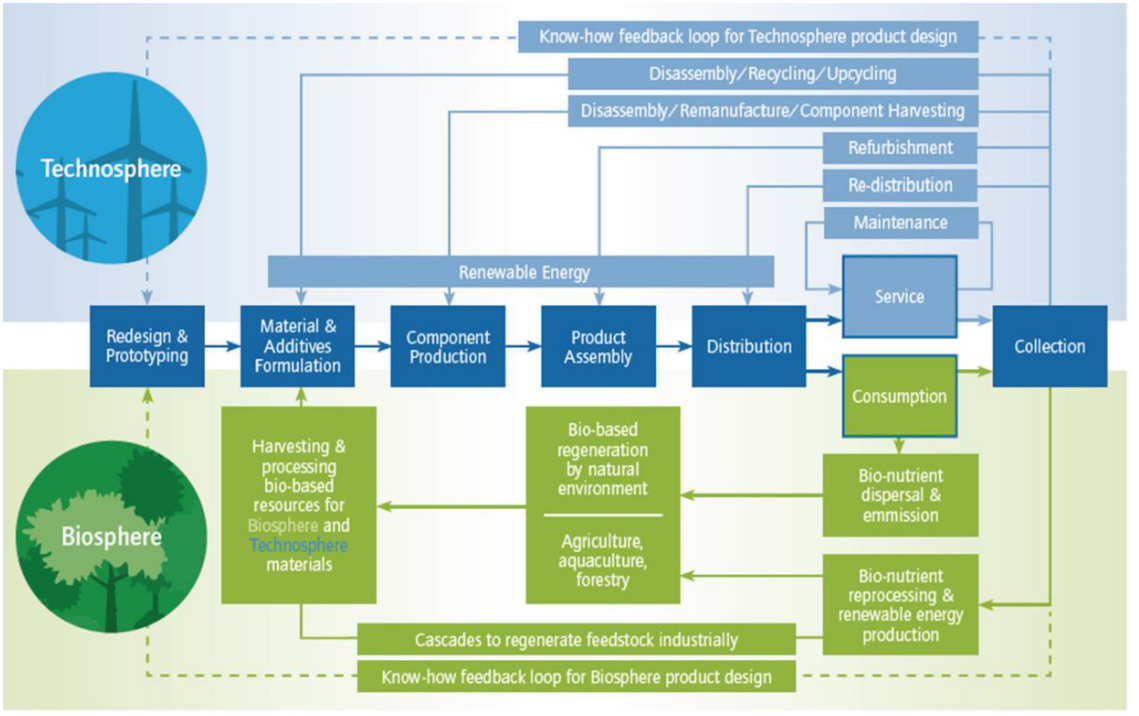

Fig. 1. Material flows in a circular economy [Source: EPEA & Returnity Partners]

With regard to architectural practice, valuable methods have been developed in the last decades to anticipate high-quality reuse of recovered materials beyond 'end-of-pipe' design solutions that only postpone the waste phase. *Design for Disassembly* (DfD) and *Design for Recycling* (DfR) are two such methods that gained ground in the building sector [7,8]. DfD and DfR focus on recyclability from a technical design point of view, aiming to reduce the negative environmental impacts of construction. Whether components and materials are actually used, reused and recycled in the intended way falls beyond the scope, but these are crucial indicators for the success of envisioned material loops. In essence those concepts are born out of a 'mitigation tradition' i.e. to lessen the effects of human activities, without exploring the potential of how those activities could actually generate positive environmental and social impacts. In