Multi-level decomposition-based analysis of LED System-in-Package design

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Introduction
LED System-in-Package (SiP) is a novel lighting concept to provide a reliable and cost-effective alternative to current LED products. The LED SiP integrates LED chips and other components into a single package. Due to the integration of components of different functionality and disciplines in shrinking spaces, the system design of the LED SiP becomes tightly coupled. This complicates the product design.

Objective
Find a method to model and analyze the LED SiP coupling structure from the product and design process perspective in order to improve the LED SiP system design practice.

Proposed method
To relate the design variables $x$ to the design objectives $f$, response functions $r = r(y, x)$ are introduced. The response functions represent the system behavior. The interactions between design variables, responses, and design objectives are represented in a representation matrix. The representation matrix is an adaption of the Design Structure matrix [2] and the Functional Dependence Table [3].

Decomposition analysis, by means of partitioning and sequencing, is subsequently carried out. Partitioning analysis is used to identify strongly coupled parts in the system design. Sequencing analysis is used to find an order in which parts of the system design should be considered in order to minimize design iterations.

LED SiP case
A LED SiP concept design is used as a case to validate the proposed method. The system design elements and their interactions are obtained by means of interviews with designers and from documentation. Figure 4 shows the representation matrix of 711 elements, which is partitioned into 10 partitions. Each partition represents a strongly coupled part of the design.

Conclusion
The proposed decomposition method provides insight in the LED SiP coupling structure. That is, which parts of the system design should be considered together and in which order in the design process.

References