Environmental analysis model for modular design of electromechanical products – Xueqing Qian

Design for environment (DFE) is an efficient design methodology to reduce the negative environmental impact of products. Recently, modular design is widely used in the design of electromechanical products. In order to greatly reduce the negative environmental impact of electromechanical products, new methodology needs to be developed to integrate DFE into modular design.

The purpose of this research is to develop a quantitative environmental analysis model for modular design. The proposed model aims at providing design support in redesign of modular design; it can be used to help designers to improve the potential environmental performance of modular design. In this research, a fuzzy graph is used to represent the structure of modular product. A set of comprehensive environmental criteria has been established for modularity analysis after analyzing the potential environmental problems through the entire life cycle of modular products. These environmental criteria include: usage life compatibility, technology life compatibility, material compatibility maintainability, disassembility(including geometric connection, disassembly time, disassembly energy) and assembility. In order to quantitatively apply all these criteria to modularity analysis, all environmental criteria are thought to be fuzzy, and fuzzy numbers are used to measure all relationship between components upon each criterion. Considering the requirements of modular design, a two-step modularity analysis scheme has been developed so that the concepts of DFE can be integrated into the process of modular design. The modularity analysis scheme includes similar analysis and independence analysis. Similarity analysis pursues the similarity or compatibility within modules, and independence analysis pursues the independence between modules. Different environmental criteria have been selected for these two kind of analysis, and fuzzy AHP is used for these two multi-criteria decision making process. In this research a deliverable prototype has been developed in Microsoft Visual C++ to illustrate the proposed methodology.