

## A Closed-Loop Design Model for Sustainable Manufacturing by Integrating Forward Design and Reverse Design

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**Abstract :** In this paper, a new concept of closed-loop design model is presented. The closed-loop design model is developed by integrating forward design and reverse design. Based on this new concept, a closed-loop design model for sustainable manufacturing by integrated evaluation of forward design, reverse design, and green manufacturing using a fuzzy analytic network process is developed. In the design stage of a product, with a given product requirement and objective, there can be different ways to design the detailed components and specifications. Therefore, there can be different design cases to achieve the same product requirement and objective. Thus, in the design evaluation stage, it is required to analyze and evaluate the different design cases. The purpose of this research is to develop a model for evaluating the design cases by integrated evaluation of forward design, reverse design, and green manufacturing models. A fuzzy analytic network process model is presented for integrated evaluation of the criteria in the three models. The comparison matrices for evaluating the criteria in the three groups are established. The total relational values among the three groups represent the total relational effects. In application, a super matrix can be created and the total relational values can be used to evaluate the design cases for decision-making to select the final design case. An example product is demonstrated in this presentation. It shows that the model is useful for integrated evaluation of forward design, reverse design, and green manufacturing to achieve a closed-loop design for sustainable manufacturing objective.

**Keywords :** design evaluation, forward design, reverse design, closed-loop design, supply chain management, closed-loop supply chain, fuzzy analytic network process

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