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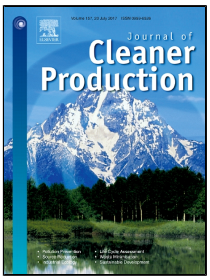


A Fault Feature Characterization Based Method for Remanufacturing Process Planning Optimization

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# A Fault Feature Characterization Based Method for Remanufacturing Process Planning Optimization

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## Abstract

Remanufacturing process planning plays a key role in implementing remanufacturing because it directly affects the remanufacturing cost as well as energy consumption and quality. Due to the uncertainty of the quality of returned used components, which are the raw materials for remanufacturing, remanufacturing process planning is far more complex than that for mass production of virgin products. In order to generate the optimal process planning, an optimization method is presented to characterize fault features for remanufacturing process planning. In this method, Fault Tree Analysis (FTA) and Fuzzy Comprehensive Evaluation (FCE) are applied to identify fault features and quantify damage degrees respectively, and Rule Reasoning (RR) and Operation Digraph (OD) methods are utilized to generate remanufacturing process plan alternatives, and then Genetic Algorithm (GA) and Artificial Neural Network (ANN) are integrated to the optimal alternative selection. Finally, a used worm gear is taken as an example to illustrate the validity and practicality of the proposed method of remanufacturing process planning, the results of which showed the proposed method is effective in optimization of remanufacturing process planning.

**Keywords:** Remanufacturing; Process planning; Fault features; Genetic Algorithm; Artificial Neural Network

**Nomenclature**

| | | | |
|---|---|---|---|
| FTA | fault tree analysis | FCE | fuzzy comprehensive evaluation |
| RR | rule reasoning | OD | operation digraph |
| GA | genetic algorithm | ANN | artificial neural network |
| $F_n$ | normal load ($N$) | $H$ | hardness of worn material ($HRC$) |
| $W_1$ | volume of adhesive wear ($mm^3$) | $W_2$ | volume of abrasive wear ($mm^3$) |
| $T$ | total remanufacturing time ($s$) | $V_s$ | synergy of $V_1$ and $V_2$ ($mm^3$) |
| $m$ | amount of additive operation | $n$ | amount of removal operation |
| $w_1$ | weight of manufacturing time | $w_2$ | weight of cost |