Chapter 52
Computational Intelligence in Used Products Retrieval and Reproduction

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ABSTRACT

Remanufacturing has become a superior option for product recovery management system. It mainly consists of three stages: retrieval, reproduction, and redistribution. So far, many different approaches have been followed in order to improve the efficiency of a remanufacturing process. However, as the complexity increases, the use of computational intelligence (CI) in those problems is becoming a unique tool of imperative value. In this paper, different CI methods, such as artificial neural network (ANN), ant colony optimization (ACO), biogeography-based optimization (BBO), cuckoo search (CS) and fuzzy logic (FL), are utilized to solve the problems involved in retrieval and reproduction stages for remanufacturing. The key issues in implementing the proposed approaches are discussed, and finally the applicability of the proposed methods are illustrated through different examples.

1. INTRODUCTION

During the last decade, the developed economies have become increasingly aware of the need to handle used products in an environmentally friendly manner. The typical practices adopted in the earlier phases of industrialization, that would dispose products reaching the end of their functional life either through dumping in landfill sites or through shredding and incineration, are reckoned to be too polluting and unnecessarily wasting precious environmental resources, by failing to retrieve and reuse materials and functional components potentially available in the discarded product. Hence, under legislative pressure in most developed countries, manufacturers proceed to

set up additional operational networks that will retrieve their products upon reaching the end of their life cycles, and if possible, reprocess and reuse the constituent components and materials. These new set of retrieval, reprocessing and redistribution operations are collectively known as remanufacturing process and their design and management defines a novel and challenging technical area of system modeling, analysis and control.

Broadly, remanufacturing refers to the business of scattered used products retrieval, reprocessing collected products and then sending them back to market "as new" (Thierry et al., 1995). There are various motives for used products remanufacturing such as increased profitability, ethical responsibility, legislation, secured spare parts supply, increased market share and brand protection (Seitz, 2007). Furthermore, remanufacturing has also been demonstrated to be environmentally preferable in comparison with other end-of-life treatments, since the geometrical form of the product is retained and its associated economic and environmental values preserved. Industries or products that typically apply remanufacturing include machine tool, medical instruments, copiers, automobile parts, computers, office furniture, mass transit, aircraft, aviation equipment, telephone equipments and so on.

Briefly, the rest of this paper is organized as follows: first, in Section 2, the background knowledge concerning used products retrieval, reproduction, and computational intelligence is introduced; then, Section 3 describes our problem statement; next, we elaborate our four focal research questions in Sections 4, 5, 6 and 7, respectively; finally, Section 8 draws the conclusions of this research and the future research directions are also highlighted in this section.

2. BACKGROUND KNOWLEDGE

A remanufacturing process is typical composed of three stages: retrieval, reproduction, and redis-

tribution. Since there are many questions need to be answered before a redistribution decision (i.e., selling remanufactured products again to customers) can be reached, in this paper, we only pay our attentions to several activities involved at retrieval and reproduction stages.

2.1. Retrieval

In remanufacturing environment, one of the major issues is the retrieval of the target items (i.e., used products in this research) (Guide & Jayaraman, 2000). It is indeed the first activity, and triggers the other activities involved in a remanufacturing process. As argued in Langella (2007), without used products being successfully collected, a remanufacturer would have nothing to remanufacturing. In general, retrieval refers to all operations rendering used products available and physically moving them to some point where further treatment is taken care of (Fleischmann et al., 2000). Used products collection, transportation, consolidation, transshipment, and storage are several common examples found at retrieval stage (Blanc, 2006). Therefore managing these operations potentially accounts for a significant part of the total costs and as a key factor in the overall performance of any remanufacturing process and its associated reverse supply chain (Fleischmann, 2001). And thus planning ahead in order to make remanufacturing profitable and in the meantime compliant with applicable laws and regulations is always suggested (Güngör & Gupta, 1999).

2.2. Reproduction

A collected used product is retransformed typically through reproduction stage. The process of reproduction starts with evaluation of returned products, following the disassembly, reusable parts are cleaned, re-machined, and put into inventory. Then the reassembly operation is performed to deal with these old but refurbished and, where necessary, new parts to produce a new product which

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