Chapter 8

Post-Disassembly Part-Machine Clustering Using Artificial Neural Networks and Ant Colony Systems

ABSTRACT

After transhipment, the remanufacturable parts/components are usually released to the reprocessing facility where the necessary operations (such as disassembly) are performed. At times, formation of parts/components for reprocessing operations is a complex problem with broad implications to an organization, both on system structure and system operations. The chapter starts with an introduction about the issue of the classification of disassembled and reusable components. Then the related studies dealing with similar problems in the literature are discussed in the background section. Next, the focal problem of this chapter is stated in the problem statement section. The authors formulate the problem as a part-machine clustering problem in which, according to similarities of reprocessing requirement, disassembled parts/components are grouped into families, and machines are organized as cells. A detailed description about the approach (i.e., adaptive resonance theory neural network and ant colony system) can be found in the proposed methodology section. Right after this, two illustrative examples are explained in the experimental study section. The potential research directions regarding the main problem considered in this chapter are highlighted in the future trends section. Finally, the conclusion drawn in the last section closes this chapter.

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INTRODUCTION

When the used products are disassembled resulting in the harvesting of components, they are then processed into the remanufactured products through different post-disassembly treatment operations such as cleaning, inspection, sorting, grading, storage of parts, re-machining, and reassembly of the product (Saavedra, Barquet, Rozenfeld, Forcellini, & Ometto, 2013). Prior to do these treatment activities based on the product groups and took place in a huge factory hall which packed with various pieces of machines. Nowadays, as the number of component commonality increases the number of alternatives and same machines may duplicate arranged, it is desirable to change the configuration of factory hall (such as the arrangement of machines, equipment selection, and assignment of operations) to one based on cells (Aksoy & Gupta, 2005; Fargher, 1997; Fidan, Kraft, Ruff, & Derby, 1998; Geren, Çakırca, & Bayramoğlu, 2006). The effect of the implementation of these improvements mainly relies on the application of group technology (GT) which groups machines into machine cells and parts into part families, respectively. As a result, these cells will improve different post-disassembly operations through standardised work, limited changeovers between different places, and better utilization of machines.

Studies (e.g., (Rafiee, Rabbani, Rafiei, & Rahimi-Vahed, 2011; Solimanpur, Vrat, & Shankar, 2004)) claimed that in designing a manufacturing cell, three major decisions must be made:

- **Cell Formation/Part-Machine Clustering**: Identify the families of parts that are assigned to production cells consisting of groups of machines;
- **Cell Scheduling**: Plan and manage cell operations; and
- **Cell Layout**: Determine layouts of cells themselves and machines within each cells.

In this chapter, we focused on the first task of the cell design (i.e., part-machine clustering), and the next two chapters will discuss with cell scheduling and cell layout issues. Two meta-heuristic methods, i.e., adaptive resonance theory (ART1) neural network and ant colony system (ACS) are developed to solve the mentioned problems. Beside in order to examine the performance, grouping efficiency (GE) is employed. Experimental results indicated that the implementing of ACS algorithm can improve the performance significantly in comparison with ART1.

BACKGROUND

Group Technology

Group technology (GT) has been recognized as the key to improve productivity. Broad speaking, GT is a manufacturing philosophy that identifies and exploits the similarities of the product design and manufacturing process in three distinct ways (Hyer & Wemmerlöv, 1984): (1) by performing like activities together; (2) by standardizing similar tasks; and (3) by efficient storing and retrieving information about recurring problems. Burbidge (1979) pointed out “that considerable reductions in setting time and therefore increases in capacity could be achieved … if similar parts were loaded on the machines one after the other.” From it appeared, there is a lot of applications have been considered in the literature. In (Hyer & Wemmerlöv, 1989), the authors reported the finding of a survey of 53 US users of GT from medium to large electronics and metalworking manufacturers. In the majority of cases, firms used classification and coding systems as tools in applying GT to design, process planning, sales, purchasing, cost estimation, tooling, scheduling, new equipment sizing, and tool selection.