Chapter 80
Hybrid Algorithms for Manufacturing Rescheduling:
Customised vs. Commodity Production

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ABSTRACT

This chapter investigates manufacturing rescheduling of customised production and compares the results with those found for commodity production in earlier research by the authors. The hybrid rescheduling algorithms presented in this chapter were obtained by combining two key rescheduling-related elements found in the literature (a) rescheduling criteria (i.e., job priority, machine utilisation and right-shift delay) with (b) level of disruption transmitted to the shop-floor due to rescheduling (i.e., High disruption and Low disruption). The main advantage of hybrid rescheduling algorithms over individual rescheduling algorithms consists of their ability to combine the main features of two different algorithms, in order to achieve enhanced performance, depending on the objective of the organisation. The five hybrid rescheduling algorithms taken into account in this chapter are: Priority High, Priority Low, Utilisation High, Utilisation Low and Right-Shift. The authors' case study research in three manufacturing companies has identified the use of a set of these hybrid algorithms in practice. Each of the case studies is evaluated in terms of time-based performance in three main areas: suppliers' interface, internal production and customers' interface. This evaluation is carried out for both customised and commodity production, using the same hybrid rescheduling algorithms and performance measure the authors used in their previous research work, for comparability purposes (i.e. the entropic-related complexity). The findings show that customised production exhibits a lower entropic-related complexity than commodity production. Although this behaviour may seem unexpected, the entropic-related complexity analysis allows for an interpretation / understanding of its underlying reasons. For example, companies making customised products first agreed the specifications of the products with the customer, and then they mutually agreed

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on a contract which would financially protect manufacturers (should last minute customer changes occur), by specifying analytically determined penalties or premium charges. Furthermore, a set of recommendations were made to the companies involved in this research study based on the analysis presented in this chapter, such as the need for manufacturing organisations of customised products to ensure they have dependable suppliers, and that, internally, they plan for and embed sufficient spare capacity to cope with internal or external disturbances.

INTRODUCTION

This chapter aims to assess the relationship between hybrid rescheduling algorithms, entropic-related complexity, and customised production, by using real-world manufacturing case studies. The paper thus makes a theoretical and applied contribution on these inter-related topics, which (to our knowledge) have not been previously studied in conjunction before.

The main research question explored in this chapter is: *In the context of customised production, how do hybrid rescheduling algorithms impact entropic-related complexity?* The following objectives guide this chapter: (a) To identify the typical hybrid rescheduling algorithms used in the context of customised production, and (b) To explain why and how hybrid rescheduling algorithms vary across organisations.

Given the current climate of increased global competition, manufacturing companies need to focus on customised production. It is important to consider the ever-increasing need for value-adding product design and manufacturing processes (Browning *et al*., 2002). Tu *et al.* (2001) argue that firms need to move from the internal efficiency maximisation mindset towards the emphasis on customer value. In the same vein, Professor ElMaraghy (ElMaraghy, 2009) states that one of the key challenges that manufacturing organisations face nowadays is "to satisfy the market need for products variations and customization, utilizing new technologies, while reducing the resulting variations in their manufacturing and associated cost" (p. v).

In order to satisfy the customization need of the market at a competitive price, it is necessary to understand that the above goals are neither straightforward nor easily achievable. Furthermore, the additional complexity that arises in trying to pursue them should be carefully managed. As Griffiths and Margetts (2000) point out: "customers want high quality products and services, at a reasonable cost, and they want them 'now'" (p. 155). Managing the complexity resulting from such a dynamic environment plays a key role in keeping costs under control. If organisations do not manage complexity through rescheduling or other complexity management approaches, they could face some of the following consequences (Huaccho Huatuco, 2003): customer dissatisfaction, which can then lead to losing customer demand and, related to this, less flexibility and product variety.

The type of rescheduling problem tackled in this chapter could be classified as a "stochastic scheduling problem" (Pinedo, 2008) where the disturbances were arbitrarily assigned, but the spare capacity of the original production schedule (processing times, number of jobs and number of loaded machines) varied according to a random probability distribution. These experiments were designed, run and tested in our previous work (Huaccho Hautuco *et al.*, 2009), so their detailed discussion is outside the scope of this chapter. The aim in this chapter is to provide manufacturing organisations that make customised products with recommendations on which hybrid rescheduling algorithms are more likely to be of effective use to them.