## Scheduling a single machine to maximize net present value

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This paper investigates scheduling a single productive resource (machine) such that the net present value of the resulting cash flow stream is maximized. The static single machine setting provides an ideal context in which to develop high value scheduling policies. A job release rule (RDE) and a job dispatch rule (MTP) are developed through a marginal cost analysis of the NPV objective, and the composite MTP/RDE scheduling rule is extensively tested against several other benchmark heuristics obtained from the literature. Results indicate that the MTP/RDE rule outperforms the benchmark heuristics by a substantial margin in providing high value schedules. Additionally, sensitivity analysis shows that the MTP/RDE rule is robust in relation to parameter settings and misspecified cost data, suggesting its applicability to real-world production settings.

## 1. Introduction

There is increasing recognition in both industry and academe that production scheduling decisions should be evaluated using a performance criterion based on the economic consequences of those decisions, rather than on surrogate or secondary measures such as flowtime or makespan. In addition, there is a growing realization that the relevant costs affecting production scheduling decisions include not only tardy delivery costs (e.g. performance penalties, lost sales, and lost goodwill), but also should include the costs of early completion (e.g. holding costs and opportunity costs). This latter assertion is borne out by the current interest shown by both practitioners and researchers in Kanban scheduling and just-in-time inventory concepts.

A problem with economic scheduling criterion is that no consensus exists as to the appropriate components of such criterion, with the result that there has existed no common basis on which to compare results across research studies. Recent proposals for improving this situation suggest evaluating schedules using the net present value (NPV) of cash flows generated by a schedule instance (Lawrence and Morton 1986, Lawrence 1988, Morton *et al.* 1988, Scudder and Smith-Daniels 1989). It has been shown that the NPV objective is a generalization of several other well-known and well-researched objective (e.g. weighted flowtime, and weighted tardiness), and it has been argued that the NPV objective provides a more complete perspective on the economic impact of scheduling decisions than do other objectives (Lawrence 1988).

In this paper, the NPV objective with forbidden early shipments is applied in the context of the static single-machine scheduling problem. Since this problem is one of the most simple and transparent scheduling environments, it provides a good starting point for developing approximate methods of generating high value NPV schedules. The contribution of this research is to develop and test a simple single-pass scheduling procedure based on marginal analysis of activity cash flow. In addition, extensive sensitivity analysis is reported which has important implications for the implementation of NPV scheduling.

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