

SCHEDULE MASTERS, INC

Introducing the SmartCutter: a New Runcutting Approach

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Introducing the SmartCutter

INTRODUCTION

The SmartCutter, from Schedule Masters, Inc. is a new runcutting option available in The Master Scheduler software version 4.9.

The following is a list of frequently asked questions about the SmartCutter.

FREQUENTLY ASKED QUESTIONS

WHAT IS THE SMARTCUTTER?

The SmartCutter is a new approach to cutting two-piece runs, that is, runs with a minimum break between two pieces of work.

The SmartCutter is capable of producing much higher-quality 2-piece runcuts such that:

- The number of valid 2-piece runs is maximized
- The leftover work is minimized
- The cost of each run is minimized
- The cost of the runcut is minimized

Like all automatic runcutters in The Master Scheduler, the SmartCutter respects all runs that you cut manually. You can also edit the SmartCutter runcut manually afterwards at any time.

WHERE DID SMARTCUTTER TECHNOLOGY COME FROM?

The SmartCutter implementation is based on the cutting-edge paper "*An Algorithm for Crew Scheduling Problem with Bin Packing Features*" published in January, 2010 by Qiao, Hamedi and Haghani at the University of Maryland (see <http://pubsindex.trb.org/view.aspx?id=909566> for details).

Schedule Masters, Inc. is constantly reviewing academic research in public transit optimization. Although many papers are published, most do not pass the following criteria to be included in The Master Scheduler:

Robust, reliable technology. There are a lot of approaches based on Linear Programming, or worse, Mixed Integer Programming. These sophisticated mathematical approaches are notorious for failing on unexpected data.

No "tuning" parameters. Any approach that requires "twiddling" with values, percentages or costs is rejected. The more "tweaking", the more that can go wrong. An approach must "just work", not depend on sensitive adjustments.

Runs on real-world problems. There are many approaches that sound promising at first, but turn out only to work on small problems. Any approach that cannot be proven to work on full-size problems is rejected.

Our research showed that SmartCutter was the right approach.

HOW DOES IT WORK?

The SmartCutter works as follows:

1. Create a set of feasible potential pieces from each block such that:
 - a. Each potential piece begins/ends at a valid relief point
 - b. Each is at least the Min Piece Size
 - c. Each is at most the Max Piece SizeThere may be tens of thousands of overlapping potential pieces for each block.
2. Starting from the earliest and longest remaining potential piece for any block, find all feasible matching potential pieces. If there are no unmatched pieces remaining, Stop.
3. If there are no feasible matches found, discard the starting piece, and return to Step 2.
4. For all the feasible matching pieces, choose the one with the best cost to make a Run. Discard all pieces that overlap the starting piece and the chosen match piece, and return to Step 2.

For maximum performance, highly efficient, purpose-built C++ data structures are used in the implementation.

HOW IS THE SMARTCUTTER DIFFERENT FROM THE EXISTING MIN-COST MATCHER?

The existing Min-Cost Matcher was an earlier approach and works as follows:

- Partition the blocks into non-overlapping potential pieces, as close to the Desired Piece Size as possible.
- Compute the run cost of every possible pair of potential pieces to form a run
- Choose feasible pairs of the non-overlapping potential pieces to minimize the total cost

The SmartCutter differs from the Min-Cost Matcher in the following key ways:

- Considers overlapping potential pieces, eliminating those it no longer needs as it forms runs. This was a key weakness of the Min-Cost Matcher, as many important run candidates could not be considered.
- Only computes the costs for pieces likely to make a good run. This was another key weakness of the Min-Cost Matcher that required every potential pair of piece to be considered, even though most of those pairs would not be chosen in the solution.

Because the SmartCutter starts with overlapping potential pieces, it can consider many more good run candidates. However, because potential runs are only “costed” when they are likely to be in the solution, the process runs very fast.

WHO WILL GET THE MOST BENEFITS?

Properties with 2-piece runs with a mandatory break will see the most benefits from the SmartCutter. These runcuts will be of much higher quality with good runtime.

However, properties with multi-piece runs using the trip planner to compute travel times between pieces will also see a performance improvement. This performance improvement was a “spin-off” effect of the SmartCutter implementation.

DO I HAVE TO DO ANYTHING BEFORE RUNNING THE SMARTCUTTER?

The SmartCutter is just a new runcutting option. All your data remains as it was, but all runcutting parameters should be checked for accuracy and completeness. Some tuning may be required in order to achieve the best results.

DO I HAVE TO PAY MORE FOR THE SMARTCUTTER?

The SmartCutter is part of our standard software. All customers current on their maintenance can get the SmartCutter as part of a regular TMS upgrade.