Scheduling TV Commercials: Models and Solution Methodologies

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Commercial advertising on television is a billion-pound industry which brings in a large percentage of the revenue for advertisement-based broadcasters (ADASSOC 2007). In order to maximize income, the broadcasters must ensure that they utilize the time devoted to advertisements in the most profitable manner possible. Commercial systems currently used by television companies to schedule advertisements are limited in the quality of the end result and flexibility to the broadcaster. Research in this area has been quite limited, with the papers that have been published generally optimizing different models. For example, Hägele, Dúnlaing and Riis (2001) models the problem as scheduling individual advertisements within three minute slots. Benoist, Bourreau and Rottenbourg (2007) schedules packages of advertisements and Bollapragada, Bussieck and Malilk (2004) investigates how to schedule a given advertisement a number of times, whilst adhering to various constraints.

In fact, just defining the problem is a challenging task as different broadcasters view the problem in different ways. Some customers require the commercial to be seen by a given number of people, and the broadcaster will schedule the commercial in order to achieve this. Others will want to have the broadcast seen by a certain demographic group. Some customers may want their commercials to be at the start/end of a given break (these being recognized as having the most impact) and others may want the commercial to be associated with a given TV programme. In addition, satellite television has made the problem even more complex. For example, in the UK, there is a network of channels collectively known as UKTV. These include UKTV Gold, UKTV Drama, UKTV History, UKTV People, UKTV Documentary, UKTV Style, UKTV Gardens and UKTV Food. Each of these channels attract different demographic groups, with some commonality across them. In addition, some of these channels have a "+1" version (where the programmes are repeated one hour later). Scheduling (and selling) commercials for UKTV is carried out across the network, rather than just one channel. With an increase in the number of television channels, the onset of alternative entertainment media options and advertisement-avoidance technology, the sale of television advertising time is becoming an increasingly competitive process. The advertiser can now demand a more effective package which guarantees (within reasonable limits) an expected audience share and certain flexibility in campaign package requirements. Legal requirements must also be taken into account with respect to content and timing (BCAP 2006), these extra constraints further adding to the complexity of the problem. There is also a dynamic nature to the scheduling requirement, where unforeseen circumstances (e.g. live events overrunning) may provide additional challenges and opportunities, with the need to minimize disruptions and maximize potential gains.

There has been work that proves the complexity of various types of commercial scheduling problems. In Hägele, Dúnlaing and Riis (2001), the problem is presented as scheduling single advertisements (known as spots) where advertisements for similar products cannot be scheduled in the same break (a break is usually a three minute period between programmes). To model this, similar products are given the same colour, with the problem being called the *colour restricted spot scheduling problem*. This is shown to be NP-Complete, even when the problem is bounded in examining optimal limits. In Benoist, Bourreau and Rottenbourg (2007) advertisements are sold as packages, rather than as individual spots. This problem, called the *tv-break packing problem*, is shown to be strongly NP-Hard. Various solution methodologies have been used for this problem. Bollapragada, Bussieck and Malilk (2004) used integer-programming, branch-and-bound and heuristic solvers for multiple-air campaigns. Brusco (2007) also used branch and bound and also simulated annealing, achieving significant improvements in terms of computation time and solution quality. Zhang (2006) provides a mathematical model for an extended definition of the problem. Benoist, Bourreau and Rottenbourg (2007) tailors the extended definition of the problem to a particular challenge faced by French satellite television. Although encouraging, the results presented are given in terms of bounds produced using Linear Programming and Lagrangian Constraint Relaxation, therefore have no direct heuristic comparison. They are also based on static schedules, which do not take into account unforeseen schedule-changes.

The test problems that are available to us provide realistic and ‘complex’ benchmarks on which to apply enhanced heuristic improvement techniques (McMullan 2007), and on which to base further modeling of the general real-world problem. Enhancements to this dataset will extend to dynamic scheduling, involving minimum perturbation techniques based on an enhanced weighted graph model (Burke et al., 2008). It is also anticipated that current links with commercial players (Sky and Disney) will provide real-world campaign data sets, either anonymised or generated based on full set of actual commercial constraints, towards the goal of a generalized system. In continuing this work, we have three aims. Firstly, we will provide a much more comprehensive review of the literature in this area, in order to provide an overview of the various problem types, and the models that are utilized to capture these problems. Secondly, we aim to explore the various solution methodologies that have been used in order to optimize the models. Thirdly, we will investigate the real-world problem faced by commercial schedulers, with the aim of improving the quality of the solutions produced and allowing fast, dynamic, minimal perturbation changes to be made to an existing schedule. This in turn allows fast, quality solutions to be obtained, but will address the problems experienced with last-minute changes to programming schedules.

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