### **ORG2006 ABSTRACTS**

## 1. Robust Airline Fleet Assignment: Imposing Station Purity using Station Decomposition, by Prof. Ellis Johnson, Georgia Institute of Technology, USA.

Abstract. Fleet assignment models are used by many airlines to assign aircraft to flights in a schedule to maximize profit [Abara 1986, Hane et al 1995]. A major airline reported that the use of the fleet assignment model increased annual profits by more than USD100 million [www.informs.org, 2002] a year over three years. The results of fleet assignment models affect subsequent planning, marketing and operational processes within the airline. Anticipating these processes and developing solutions favorable to them can further increase the benefits of fleet assignment models. We develop fleet assignment solutions that increase planning flexibility and reduce cost by imposing station purity, limiting the number of fleet types allowed to serve each airport in the schedule [Smith and Johnson 2005]. Imposing station purity on the fleet assignment model can limit aircraft dispersion in the network and make solutions more robust relative to crew planning, maintenance planning and operations.

Because imposition of station purity constraints can significantly increase computational difficulty, we develop a solution approach, station decomposition, which takes advantage of airline network structure. Station decomposition is an instance of Dantzig-Wolfe decomposition and uses a column generation approach to solving the fleet assignment problem. We further improve the performance of station decomposition by developing a primal-dual method that increases solution quality and reduces running times. This method can be applied generally within the Dantzig-Wolfe decomposition framework to speed convergence. It avoids "instability of the duals" and minimizes the "tailing" effect.

Station decomposition solutions can be highly fractional causing excessive running times in the branch-and-bound phase. We develop a "fix, price, and unfix" heuristic to efficiently find integer solutions to the fleet assignment problem.

Station purity can provide benefits to airlines by reducing planned crew costs, maintenance costs, and the impact of operational disruptions. We show that purity can provide compelling benefits (up to USD29 million per year) to airlines based on reduced maintenance costs alone. Benefits associated with reduced crew costs are estimated at USD100 million per year, giving USD129 million per year increased profit. We would expect additional savings in operations.

#### References:

Abara, J. (1989), "Applying Integer Linear Programming to the Fleet Assignment Problem" Interfaces 19 pp. 20-28.

Hane, C. A., C. Barnhart, E. L. Johnson, R. E. Marsten, G. L. Nemhauser, G. Sigismondi (1995), "The Fleet Assignment Problem: Solving a Large-scale Integer Program" Mathematical Programming 70 pp. 211-232. [http://www.informs.org/Press/EDELMAN02.html]

Smith, B. C., E. L. Johnson (2005), "Robust Airline Fleet Assignment: Imposing Station Purity using Station Decomposition", submitted.

# 2. Combining Multiple Objective Programming and Simulation Techniques: Case Studies in Healthcare and Inventory Management, by Prof. Dylan Jones, University of Portsmouth, UK.

Abstract. Multi-objective programming techniques are increasingly being used in combination with other techniques from the field of Operational Research in order to provide a more effective analysis. This seminar examines one such combination, that of multiple objective programming and simulation. A review of the theory and the current-state-of-the-art of this topic is given. Two case studies are presented. The first uses discrete event simulation and goal programming. It involves the modelling of a medical assessment unit at a hospital in order to improve patient flow and find optimal levels of resources. The second is a theoretical inventory control model which combines aspects of simulation, local search, and multiple objective decision making.

3. Computational Optimization for Cancer Therapeutics, by Prof. Eva Lee, Georgia Institute of Technology, USA.

**Abstract.** Treatment planning for radiation therapy is inherently complex due to the number of input parameters involved. The complexity is amplified by the uncertainty of target shapes due to organ motion, by dose estimation, by availability of biological information, and by competing multiple clinical objectives within the planning procedure. In this talk, we describe some of our experience in cancer treatment design related to these issues. Various optimization methods will be contrasted, and computational challenges will be discussed.

4. Goal Driven Optimization, by Prof. Melvyn SIM, National University of Singapore, Singapore.

Abstract. Achieving a targeted objective, goal or aspiration level are relevant aspects of decision making under uncertainties. We develop a goal driven stochastic optimization model that takes into account an aspiration level. Our model maximizes the shortfall aspiration level criterion, which encompasses the probability of success in achieving the goal and an expected level of under-performance or shortfall. The key advantage of the proposed model is its tractability. We show that proposed model is reduced to solving a small collection of stochastic linear optimization problems with objectives evaluated under the popular conditional-value-at-risk (CVaR) measure. Using techniques in robust optimization, we propose a decision rule based deterministic approximation of the goal driven optimization problem by solving a polynomial number of second order cone optimization problems (SOCP) with respect to the desired accuracy. We compare the numerical performance of the deterministic approximation with sampling approximation and report the computational insights.

### 5. Should Small Firms Be Cautious? Dynamic Programming Models of Inventory and Production in Small Firms, by Prof. Lyn Thomas, University of Southampton, UK.

Abstract. Inventory and production models have traditionally sought to maximize profit or minimise costs. While these are sensible objectives for well established companies with good reserves of capital, small firms have a very different objective - to survive. We consider how changing the objective to one of maximising the probability of survival affects the inventory and production decisions of such firms. We show that for the basic inventory problem small firms should be more cautious than large ones, even though they cannot afford to be too cautious. An extension of the newsboy problem, to represent small firms which have bought franchises, is then considered as well as models of small production companies which have to set both inventory and production levels. In the former case the small firm still needs to be cautious unless it has hardly any capital when it should take substantial risks. In the latter the firm should usually, but not always match inventory and production levels.

## 6. A Semidefinite Programming Approach to Graph Realization, by Prof. Yinyu Ye, Stanford University, USA.

Abstract. In this talk, we show that the semidefinite programming (SDP) can be used for realizing graphs in 3-dimensional space. Specifically, we use SDP duality theory to show that given a graph G and a set of lengths and/or bounds on its edges, the optimal dual multipliers of a certain SDP give rise to a proper equilibrium stress for realization of G. Using this result and other techniques, we then obtain an algorithm for realizing all 3-realizable graphs. In particular, we show how to use SDP to pack unit-balls to achieve the largest "kissing number".