Annotated Bibliography

This document is meant as a repository of notes on literature that I've been reading in a variety of areas. Some of it will end up being helpful for my research related to airspace demand management through congestion pricing and user incentives. Some of it will likely not be relevant for my research when I start narrowing in on topics, but I'm keeping my notes on it anyways. I expect that as I proceed with my research I will pull off subsets of these papers and organize them into subtopics more closely related to what I would like to do. For a current high-level categorization of some of these papers see this file.

The annotation for each work is my interpretation of the research performed, and does not necessarily represent the views of the original authors. This file is organized alphabetically by first author. For a straight list of these works without the notes, see the plain bibliography. For more information on the motivation for this work, go to `http://www.people.virginia.edu/~bph4r`

Please direct any comments or corrections to me at bph4r@virginia.edu

Brendan Hogan
Last modified: March 1, 2007

References

[1] Leonard Adelman, Matthew Christian, James Gualtieri, and Karen L. Johnson. Examining the effects of cognitive consistency between training and displays. *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans*, 28(1):1–16, January 1998.

KEY: adelman:smc98
ANNOTATION: **Intro** Prior research has shown an 'order effects bias' in which the sequence conflicting information is presented with has a significant effect on the decisions made. In other words they might have been overweighing the most recent information in an additive processing rule. However, it turns out the real problem was inconsistency between how the system displays its reasoning and the operator's reasoning (the 'display cognitive consistency hypothesis'). This paper experimentally examines this display cognitive consistency hypothesis.
Method This experiment consisted of a $2 \times 3 \times 2$ factorial design representing training (additive, explanation-based), display (additive, explanation-based, no assistance), and tracks (previously used, new), respectively. Note that in the additive rule training, subjects were given specific positive and negative weights for various hostile and friendly cues to aid their decisions. In the explanation based training, subjects were given given different scenarios showing why a friendly aircraft may give off hostile cues, and vice versa. Rather than quantifying things, this allows them to put together stories of why a situation might develop. In the additive display the cue weights are shown as a reminder as well as a graph of the cumulative sum of the weights based on the track, and a recommendation for the decision. In the explanation based display, the ranking of the cues was given instead of a quantification of their weights, and a textual interpretation of the cues for the track were given along with the recommendation. In the no assistance display, neither a graphical nor textual interpretation of the track cues as friendly or hostile were given, only a ranking of the cues. The tracks were organized based on the initial information (friendly or hostile), side of the display (left or right), and the late order sequence (sequence of confirming/disconfirming the initial info with late track info). The dependent variables that were measured were the extent to which participants agreed with the system's recommendations (testing the display cognitive consistency hypothesis) as well as the time it took participants to made the decision (as a surrogate for the cognitive effort, and to test the relationship between this and cognitive agreement).
Results They found significant main effects for the display and for the tracks (old vs. new) but counter to their predictions, not for the training or the training $\times$ display interaction. Their conclusions is that a situation-specific rather than a global focus for understanding interaction with design. In other words three perspectives must be considered, the type of decision that would be made solely based on training, whether the system's recommendation and displayed rationale are consistent with that training, and whether the pictoral representation of the aircraft is consistent with that training. A couple of examples are given in the paper of different intuitive and un-intuitive reactions to training and display combinations supporting this point of view that the set of training/display/track must be considered to understand a certain situation. Regarding the decision time, there was a significant effect for the display but the specific results (additive $>$ NDA $>$ EBR) suggest a minimal relationship between global agreement and decision time. There was also a significant main effect for tracks as well as the training $\times$ display $\times$ track interaction, but overall there was minimal support for the predicted inverse relationship between agreement and decision time.

Discussion They did not find support for the global display cognitive consistency hypothesis, but rather that one must take a situation-specific focus to display cognitive consistency. Trained operators use more than one judgement process (even when they're trained a specific way) and the situation-specific characteristics trigger when different processes are used. If there are inconsistencies between training and display, either the system's recommendation will be discounted or the displayed rationale will be used to explain away the contradictory evidence based on training. Also having consistent displays does not necessarily mean shorter decision times, as their results show the decision times are linked with the type of display regardless of the training that's paired with it. In the specifics of their experiment this is largely due to the extra time it took to process explanation based displays. The situation explored here is challenging in that events occur that are unfamiliar to operators and that have not anticipated by designersd. Further research is needed before providing meaningful guidance to display designers for situations like this.

[2] Bhim Adhikari. Literature review on the economics of common pool resource management. Technical report, NRSP Project R7857, 2001.

KEY: adhikari:nrsp01
ANNOTATION: This is a high level overview paper that defines some concepts in Common Pool Resource Management (CPRM) and the costs associated with different modeling techniques. No specific details on implementing a CPRM solution are discussed, just theoretical concepts. Note that the tragedy of the commons is when there's open access to a resource and no individual bears the full cost of degredation, and it leads to "free riding" and over exploitation. In open access regimes individual interests are unlikely to lead to sustainable management of public goods in open access, therefore governance needs to modify incentives. In common property regimes, a well delineated group of competing users participates in extraction of a jointly held resource according to access rules. Transaction costs associated with these access methods could include search and information costs, bargaining and decision costs, and policing and enforcement costs. The incentive for compliance depends on the direct benefits for compliance as compared to defection.

[3] Algers and Beser. Modeling choice of flight and booking class - a study using stated preference and revealed preference data. *International Journal of Services Technology and Management*, 2(1/2):28–45, 2001.

KEY: algers:ijstm01

[4] Gene Amromin, Carrie Jankowski, and Richard D. Porter. Transforming Payment Choices by Doubling Fees on the Illinois Tollway. *SSRN eLibrary*, 2006.

KEY: amromin:ssrn06
ANNOTATION: Another approach to studying user response to pricing changes, could be helpful as a reference.

[5] Simon P. Anderson and Andre de Palma. The economics of pricing parking. *Journal of Urban Economics*, 55:1–20, 2004.

KEY: anderson:jue04
ANNOTATION: The first author is a professor of economics at UVA and has published extensively on pricing issues. He could be a good resource to bounce ideas off.

[6] Giovanni Andreatta, Lorenzo Brunetta, Luca Righi, Alessia Barella, and Amedeo Odoni. Design of economic demand management strategies: Impact of alternative route charging schemes on airlines during a selected 2002 week. Technical report, EUROCONTROL Innovative Route Charging Schemes Work Package 6 Part I, December 2003.

KEY: andreatta:wp6.1
ANNOTATION: This is part I of the work package in which they evaluate several charging scenarios adapted from the current EUROCONTROL practice, however this still does not include congestion impacts, or modifying the fees for peak periods. This is closely relaed to the work they presented at ATM2005.

[7] Giovanni Andreatta and Amedeo Odoni. Preliminary investigation on market-based demand management strategies for european airports and air routes. (Accessed from EUROCONTROL IRCS site, file labeled EEC), 2001.

KEY: andreatta:prelim01
ANNOTATION: The authors recognize that capacity growth is expensive and ultimately limited in possibility, therefore there is motivation to pursue economic (market-based) incentives. Their approach in the en-route environment is to consider adding a congestion component to the current square-root of weight fee formula used by EUROCONTROL. To do this they need an estimate of airline elasticity to en-route navigation charges.

In a no-congestion scenario they would fix charging between sectors for the economic indifference point, whereas in a light congestion scenario the estimated delay time would be incorporated into the rates to keep the indifference point. Basically they suggest fixing the rates so that the cumulative fees collected are the same but redistribution of demand occurs due to the market forces. This ia a hypothetical proof-of-concept paper dealing with small network examples. Regarding airline elasticity to routes the authors state 'it is reasonable to expect that airline elasticity is lower than passenger elasticity and furthermore that different airlines have different elasticities according to passenger topology'. This makes sense in light of comments I heard at a FAA User Forum conference in Summer 2005 that business jet operators just want to get off the ground as soon as possible, even if they end up flying longer routes. This appears consistent with the authors observations that charter operators are more willing to try alternate routes than traditional airlines.

[8] Giovanni Andreatta and G. Romanin-Jacur. Aircraft flow management under congestion. *Transportation Science*, 21:249–253, 1987.

KEY: andreatta:ts1987

[9] Richard Arnott, Andre de Palma, and Robin Lindsey. A structural model of peak-period congestion: A traffic bottleneck with elastic demand. *American Economic Review*, 83(1):161–179, March 1993.

KEY: arnott:aer93

[10] Lisanne Bainbridge. Ironies of automation. *Automatica*, 19(6):775–779, 1983.

KEY: bainbridge:auto83
ANNOTATION: Increasing levels of automation can increase, rather than decrease, the problems of supporting the human operator.

[11] Michael Ball, George Donohue, and Karla Hoffman. *Combinatorial Auctions*, chapter Auctions for the safe, efficient, and equitable allocation of airspace system resources, pages 507–538. MIT Press, 2005.

KEY: ball:mit05

[12] Moshe E. Ben-Akiva and Steven Lerman. *Discrete Choice Analysis: Theory and Application to Travel Demand*. MIT Press Series in Transportation Studies. MIT Press, January 1985. ISBN: 0262022176.

KEY: benakiva:mit85
ANNOTATION: This textbook is a main, comprehensive reference in the field. A chapter or two from this book could be very useful as an overview of specific subtopics in choice modeling.

[13] Dimitris Bertsimas and Sarah Stock Patterson. The traffic flow management rerouting problem in air traffic control: A dynamic network flow approach. *Transportation Science*, 34:239–255, 2000.

KEY: bertsimas:ts2000

[14] Ann M. Bisantz and Amy R. Pritchett. Measuring the fit between human judgements and automated alerting algorithms: A study of collision detection. *Human Factors*, 45(2):266–280, 2003.

KEY: bisantz:hf03
ANNOTATION: There has to be some match between the algorithm and the display to those that are using it.

[15] Matthew Bishop and David Thompson. Peak-load pricing in aviation: the case of charter air fares. *Journal of Transport Economics and Policy*, 26(1):71–83, January 1992.

KEY: bishop:jtep92
ANNOTATION: This paper looks at the effect of airport and airspace congestion on direct operating costs, as it is passed on to customers through the price of charter aviation services.

[16] Jan K. Brueckner. Network structure and airline scheduling. *Journal of Industrial Economics*, 52(2):291–312, June 2004.

KEY: brueckner:jie04
ANNOTATION: In separate file.

[17] Lorenzo Brunetta, Luca Righi, Giovanni Andreatta, and Amedeo Odoni. Analysis of alternative routes for selected city pairs. Technical report, EUROCONTROL Innovative Route Charging Schemes Work Package 6 Part II, December 2003.

KEY: brunetta:wp6.2
ANNOTATION: The goal of this project is to select a set of city pairs and analyze alternative routes for those city pairs, and to provide a simulation of the impact that congestion fees would have on airline route selection. The specific city pairs that they choose for this exercise are the 45 most congested city pairs in Europe, and they analyze data from the test of August 26 - September 1, 2002. For each of the congested city pairs they study, there is a route that is preferred by most (85 percent) of the airlines. On some city pairs however, there are distinct route preferences by type of airline, weekday or weekend, or time of day (see pp. 30-32 for an example). From this analysis they observe the most 'creative' airlines in their route selection are the charter carriers. They then used a simulation to compute the range of ATC charges that would make a new route preferable on the basis of direct operating cost estimates. These cost estimates are done for the most common type of equipment for each airline category, and the actual estimates are derived from average DOC's for US airlines from BTS Form 41 Financial - Schedule P52 data. They find in general that airlines are relatively inelastic to changes in route charges, with charter airlines more willing to change than others. Within the framework of setting the overall fee revenue with congestion pricing equal to the revenue in the current charging system their results do not look very promising as a means of altering routing decisions since the EUROCONTROL fees are so small compared to overall operating costs. For future research they suggest studying the extent to which delay is taken into account in routing decisions, whether congestion fees could convince airlines to reroute more than they already do when there's delay, and whether delay would significantly decrease as a result.

[18] Jason Burke. Implementing and evaluating alternative airspace rationing methods. Master's thesis, University of Maryland, 2002.

KEY: burke:umd02
ANNOTATION: My initial reaction is that this work built a software prototype analagous to CRCT for displaying and evaluating delay and/or rerouting options to deal with airspace congestion. He also aligns himself closely with the CDM long term collborative routing group and the discussions they had. Was this a precursor to Airspace Flow Programs (AFPs)?

[19] Keith C. Campbell, Wayne W. Cooper, Daniel P. Greenbaum, and Leonard A. Wojcik. Modeling distributed human decision-making in traffic flow management operations. In *3rd USA/Europe Air Traffic Management R&D Seminar*, Napoli, Italy, June 2000.

KEY: wojcik:atm00
ANNOTATION: This paper uses agent based modeling to study the interactions of airlines and air traffic control in the traffic flow management environment.

[20] Lorenzo Castelli, Raffaele Pesenti, and Walter Ukovich. Analysis of airline operational behaviours. Technical report, EUROCONTROL Innovative Route Charging Schemes Work Package 4, December 2003.

KEY: castelli:wp4
ANNOTATION:

[21] Lorenzo Castelli, Raffaele Pesenti, and Walter Ukovich. Study of ATS demand elasticity of airspace users. Technical report, EUROCONTROL Innovative Route Charging Schemes Work Package 5, December 2003.

KEY: castelli:wp5
ANNOTATION: This work considers mainly decisions on prices and frequencies for a hypothetical single market. They consider a couple different angles to the problem, including an industry level look at airline operating cost impacts (Chapter 2), a single airline focus with respect to position within the market (Chapter 3), and a qualitative detailed look at relations between factors affecting airline behavior (Chapter 4). They conclude that airlines and passengers are inelastic with respect to route charges but not indifferent to them. This is a nice example of varying the scope of an analysis with different assumptions. In the single airline focus of Chapter 3 they consider the oligopolistic case of both Cournot pricing (deciding the number of pax to serve, let the market determine the price) and Bertrand pricing (decide the price, let the market determine the demand). In each case the elasticities are developed as well as the desired responses with price and frequency. In the focus on airline behavior in Chapter 4 they present a very detailed influence diagram highlighting the relationships between elements in the cost/revenue structure of airlines.

[22] Lorenzo Castelli, Walter Ukovich, and Philipe Debels. Route charging policy for a functional block of airspace (CEATS). In *6th USA/Europe Air Traffic Management R&D Symposium*, 2005.

KEY: castelli:atm2005
ANNOTATION: CEATS stands for the Central European Air Traffic Service. This work basically builds on the earlier EUROCONTROL study and flushes out an actual example with detailed data. There are three pricing approaches considered in the paper: National Cost Base (NCB) which still has costs based on national boundaries, Single Unit Rate in Upper Airspace (SUU) which is going to have a different effect on regional vs. long-haul carriers, and Single Unit Rate in All Airspace (SUA) in which regions would have to agree on compensating each other for different costs. (Since today it is purely a cost-recovery system on the level of individual countries.) This is a static analysis on a test week of past data (April 14-20, 2003) looking at the effect on type of airline due to the charging schemes. For example they mention that regional airlines get higher unit costs than those just occasionally passing through under some scenarios, so it is important to consider these types of equity questions. Note that this paper does NOT consider congestion impacts in the pricing schemes or airline response, but it contains some foundations that would be important in such a congestion study.

[23] Gregory M Coldren and Frank S. Koppelman. Modeling the competition amond air-travel itinerary shares: Gev model development. *Transportation Research Part A*, 39(4):345–365, 2005.

KEY: coldren:trA05
ANNOTATION: This paper models the inter-itinerary competition dynamic with respect to three main variables: time of day, carrier, and level of service (direct vs. connecting). The tools they use to do this are the multinomial logit model and variations of the nested logit model.

[24] Scott T. Crino. *Combining multivariate adaptive regression splines with a response surface methodology for simulation-based design optimization*. PhD thesis, University of Virginia, 2006.

KEY: crino:uva06
ANNOTATION: Finite element models are computationally expensive so RSM is used for an efficient experimental design and the screening of important variables. MARS (multivariate adapative regression splines) uses piecewise continuous linear approximations to fit the surface so that variables act locally rather than globally. SRSM (successive RSM) changes the size and location of the test region based on proximity and degree of oscillation of the best response from successive batch samples.

[25] Scott T. Crino and Donald E. Brown. Global optimization with multivariate adaptive regression splines. *Forthcoming*, 2007.

KEY: crino:smc07
ANNOTATION: Finite element models are computationally expensive so RSM is used for an efficient experimental design and the screening of important variables. MARS (multivariate adapative regression splines) uses piecewise continuous linear approximations to fit the surface so that variables act locally rather than globally. SRSM (successive RSM) changes the size and location of the test region based on proximity and degree of oscillation of the best response from successive batch samples.

[26] Achim I. Czerny and Henning Tegner. Secondary markets for runway capacity. Technical report, Berlin University of Technology, 2002.

`http://www.imprint-eu.org/public/Papers/IMPRINT\_Czerny\&Teg%`
`ner.pdf`

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KEY: czerny:but02
ANNOTATION: Worth taking a look at.

[27] Joseph I. Daniel and Munish Pahwa. Comparison of three empirical models of airport congestion pricing. *Journal of Urban Economics*, 47:1–38, 2000.

KEY: daniel:jue00
ANNOTATION:

[28] P. Leal de Matos. Yield management for privatised air traffic control? *Journal of the Operational Research Society*, 52:888–895, 2001.

KEY: deMatos:jors01
ANNOTATION: This has some interesting references cited, including Odoni's conjestion pricing paper, and some decision support system work he had done previously (for his PhD).

[29] Karine Deschinkel, Jean-Loup Farges, and Daniel Delahaye. Optimizing and assigning price levels for air traffic management. *Transportation Research Part E*, 38:221–237, May 2002.

KEY: deschinkel:trE02
ANNOTATION: The motivation for this paper is very close to the work that I would like to do, namely that airspace pricing policies can be used to minimize en-route congestion. The options users are allowed are a combination of departure time and route. A utility is assigned to each option based on the flying cost, cost of ground delay, and prices of the sectors involved. The approach the authors take to restricting the number of price levels and assigning them to sectors involves a simulation based on a logit discrete choice model. These calculations are iterated with simulated annealing used to assign a price level to each sector at each time period, and a gradient algorithm used to calculate new values of the price levels.

[30] Thomas Dietz, Elinor Ostrom, and Paul C. Stern. The struggle to govern the commons. *Science*, 302, December 2003.

KEY: dietz:sci03
ANNOTATION: This paper was recommended by Jen as next readings into the issues and applications of CPRM.

[31] Gerald Dillingham. Observations on potential FAA funding options. Technical Report GAO-06-973, U.S. Government Accountability Office (GAO), September 2006.

KEY: gao:gao06
ANNOTATION: The report reviews the issues surrounding the Airport and Airways Trust Fund and the FAA's current funding mechanism, in light of the upcoming Congressional reauthorization. The basic arguments for and against the current funding system consisting of excise taxes are presented. Six alternative tax funding structures are discussed, including the pros and cons of each with respect to linking costs with revenue, equity, and related issues. Two of the alternatives discussed are modifications on the current excise tax system, relying solely on a fuel tax, and increasing the segment tax to replace the ticket tax. Four of the alternatives discussed involve charges more directly linked with operations, including weight/distance charges (i.e. a formula that includes these factors), en-route charges (based on either time or distance en-route), flight segment charges, and certification charges (based on each certificate issued).

[32] Joshua Epstein. *Handbook of Computational Economics Volume 2: Agent-Based Computational Economics*, chapter Remarks on the Foundations of Agent-Based Generative Social Science. Elsevier, 2006.

KEY: epstein:abm06
ANNOTATION: Paper recommended by Len as an overview to agent-based modeling. The author is associated with the Sante Fe Institute. There is a nice review of this entire volume by Herbert Gintis available at http://jasss.soc.surrey.ac.uk/10/1/reviews/gintis.html

[33] Ido Erev, Greg Barron, and Roger Remington. Right of way in the sky: Two problems in aircraft self-separation and the auction-based solution. *Human Factors*, 46(2):267–276, 2004.

KEY: erev:hf04
ANNOTATION: Currently ATC is a non-competitive entity within the competitive air carrier environment. Under a free flight system self-separation could be handled in one of two ways, the aircraft in conflict negotiate a solution, or right of way rules could be followed similar to VFR flights today. The main goal of this paper is to highlight the behavioral implication of some options considered by designers of the new rules. This is based on two observations from prior literature, that the expected behavior of rational agents can be derived, and when human agents learn from experience, reinforcement learning models can capture the direction and magnitude of deviations from rational choice.
The method used in this work focuses on simple scenarios which demonstrate interesting dilemmas and propose solutions. The behavior of rational agents assumes selfish agents which maximize their expected return assuming the other agents do the same. Deviations from rationality use a quantification of the law of effect (this learning model is from their previous work, Erev and Barron, 2003). They point out two shortcomings of the current system as motivation for the proposed solutions. That is, right of way should be given to the aircraft that values it most, and the conflict should not incur additional costs on the system. They give an example of two routes, one of which is longer and involves an extra cost, and two aircraft competing for the routes each

of which have different costs if they lose the right of way (and are delayed). This is developed as a game, specifically a prisoner's dilemma to show the economic inefficiency of the current situation. Possible solutions:

- free negotiation with stated cost rule - won't work since each player has incentive to state overly high costs, the efficiency rate converges to 50%
- alternating offer rule (with patient and impatient agents) - bargaining power goes to the patient, this also converges to 50% efficiency
- negotiation with side payments - this creates an incentive for lower cost aircraft to initiate conflicts with higher cost aircraft, and additional costs will be incurred on the system
- sealed bid auction solution - this is the preferred approach and the only one that ensures 100% efficiency

There are two variants of the sealed bid auction considered, first price in which the winning airline pays it's bid, and second price (Vickery auction) in which the winning airline pays the loser's (lower) bid. In both cases the lower biddeing airline (or aircraft) pays nothing and gets nothing, the payment goes to a third party assumed to invest the money back into a common good. In a first price auction, bidding a proportion of the true value is the equilibrium strategy, specifically the average between your true value and the lowest bid. Ina second price auction, bidding your true value is the dominant equilibrium strategy. Two additional options considered for each sealed bid auction type are whether it is public (both sides know what the other bid and therefore what outcomes could have been obtained by bidding differently) or private. The various combinations of these factors are explored experimentally in this paper and their results show second price public bidding is the most efficient given adaptive agents.

[34] Alfredo Garcia, Enrique Campos, and Natalia Fabra. Dynamic auctions for on-demand services. Technical report, UVA Systems and Information Engineering, 2004.

KEY: garcia:sie04

[35] David M. Grether, R. Mark Isaac, and Charles R. Plott. The allocation of scarce resources: Experimental economics and the problem of allocating airport slots. In *Underground Classics in Economics Series*. Westview Press, 1989. ISBN 0-8133-7543-6.

KEY: grether:uces89
ANNOTATION: These notes are actually taken from a review of this work (until I locate the original paper) by Michael McKee in the Journal of Economic Literature, Vol. 28, No. 2, June 1990, pp. 711-713. A main explanation for going with an experimental economics approach is that it's much easier to explain intricate policy questions to policy makers through a description of behavioral results than through predictions of elaborate models. They conclude through lab experiments that existing airport slot allocation methods by committee are inefficient. They propose an auction mechanism with a computerized after-market and the revenues taken in going towards airport expansion. In order to draw policy inferences from lab experiments, it is necessary to show parallelism between the experiment and the system being modeled. This involves two things, that the structure of the incentives is captured in the experimental design, and that subjects are provided sufficient information for informed decision making. There are some more good references mentioned in here on experimental economics.

[36] Katherine Thomas Harback and Joseph I. Daniel. Do airlines that dominate traffic at hub airports experience less delay? Technical report, University of Delaware Department of Economics Working Paper No. 2005-09, 2005.

KEY: harback:udel05.9
ANNOTATION:

[37] Katherine Thomas Harback and Joseph I. Daniel. Do hub airlines internalize their self-imposed congestion delays? Technical report, University of Delaware Department of Economics Working Paper No. 2005-08, 2005.

KEY: harback:udel05.8
ANNOTATION:

[38] Ken Hendricks, Michele Piccione, and Guofu Tan. Equilibria in networks. *Econometrica*, 67(6):1407–1434, November 1999.

KEY: hendricks:econ99
ANNOTATION: From Garcia.

[39] Marco A. Janssen and Elinor Ostrom. Critical factors that foster local self-governance of common-pool resources: The role of heterogeneity. In *Annual Meeting of the Resilience Alliance*, Chiang Mai, Thailand, August 2001.

KEY: janssen:ra01
ANNOTATION: Ostrom is a leader in the field of common pool resource management. This particular paper uses an agent modeling approach to study the governance rules that develop when multiple agents interact. So it could be relevant and helpful for a couple of concepts I am considering.

[40] Bertold Keuleers, Vincent Chow, Neil Thorpe, Harry Timmermans, and Geert Wets. Behavioural change in activity-travel patterns in response to road user charging. *Journal of Transport Economics and Policy*, 40(1):119–134, January 2006.

KEY: keuleers:jtep06
ANNOTATION: This should have some good ideas to consider regarding modeling user response to pricing schemes. Note: I have not yet located this actual article though. (but I do have a preliminary version presented at TRB2003) This work reports on a field experiment where users were given money and asked to behave as if they were experiencing a congestion pricing scheme. Decision trees and rule-induction systems were used to analyze the changes before/after the pricing scheme was put in place. Based on the TRB2003 paper, this may be a candidate for looking at later but I don't think it is that relevant for the qualifying exam.

[41] Alex Kirlik. Modeling strategic behavior in human-automation interaction - why an 'aid' can (and should) go unused. *Human Factors*, 35(2):221–242, June 1993.

KEY: kirlik:hf93
ANNOTATION: Automation aids can create new tasks in terms of when to engage/disengage the automation. Knowledge is required of the factors influencing strategy selection to predict system-level effects of introducing operator aids. This research focuses on the design and use of task-offload aiding. If an operator perceives the potential benefits of an aid are outweighed by the engagement and disengagement burdens, the aid may go unused. The overall task context is very important as well in whether an aid gets used or not.
Experimental Task Simulated cockpit tasks for a scout helocopter are explored with human subjects. Autopilot is available at all times, but the max speed with autopilot is just 75% of the max speed under normal control, and the fuel burn is worse with autopilot as well. Subjects also have supervisory control over four friendly helos to help with the missions.
Strategies for Autopilot Use It was expected (and the system was designed so) that crews would use manual control except when they needed to enter commands for the friendly helos and would switch to autopilot then. None of the subjects actually used this strategy of using autopilot as a task off-loading aid. Their hypothesis why is that the time to program and engage the autopilot was relatively long with respect to the duration of the text editing sessions (secondary tasks).
Factors Influencing Strategy Selection The goal of the work is to determine optimal parameters for using autopilot as a functoin of design and task-context parameters. The autopilot design factors considered include the manual ability to control the helocopter relative to the autopilot ability to control, the engagement time and the disengagement time for autopilot. The task context features include the duration of secondary tasks requiring diversion of attention, the cost associated with delaying secondary tasks, and the interval duration between secondary tasks.
Markov Decision Process Modeling The continuous time MDP involves a set of states, state transition rates, a set of actions available in each state, and a reward for the occupancy time in each state. A policy is an action to be selected in each state. Their model includes 4 states (the combinations of manual/autopilot, with either editing taks required or no-editing tasks required. The two actions available from each state are to select autopilot or select manual control (including maintaining the current control option). Other aspects of the model include the assumption of exponentially distributed state occupancy times, reward of 1 unit/sec for autopilot control, reward of M units/sec for manual control, and a penalty of P units/sec for delaying secondary tasks. The state transition probabilities and transition rates specified in terms of mean engage/disengage/time between editing tasks/time of editing tasks.
Sensitivity Analysis Approach A policy improvement algorithm (detailed in Appendix) was used to identify optimal decision policy and the maximum level of expected performance as a function of the 6 model parameters. The sensitivity analysis focused on the three parameters from the hypothesis as to why the automation wasn't used as the task-offloading aid it was designed for (i.e. the penalty for delaying editing tasks, manual control performance relative to automation performance, and the engagement time).
Modeling Results In the sensitivity analysis they observed when the optimal policy was to use automation as a task-offloading aid as intended. It turns out this was only the case for the combination of very low delay

penalties, high manual performance, and low engagement times (which explains why no humans actually used the policy).

Individual Differences in Strategic Behavior As a performer becomes increasingly competent at the skills for a particular strategy, he will have less opportunity to hone the skills necessary for alternate strategies. That is, the nature of the parameter space changes dynamically. Understanding the strategy development requires knowing how the parameter space shapes behavior, and how the behavior shapes the parameter space (closed loop dynamics).

Discussion Successful performance prediction requires techniques for environmental modeling that are just as rich, precise, and formal as the techniques for modeling the human operator.

[42] Mark W. Klopfenstein, Gretchen Wilmouth, Philip J. Smith, Amy Spencer, M. Jon Mintzer, and Ved Sud. Congestion management via interactive dynamic flight lists and customer submitted multiple routing options. In *Proceedings of the 5th AIAA Aviation Technology, Integration and Operations (ATIO) Conference*, Arlington, VA, September 2005.

KEY: klop:atio05

ANNOTATION: This is a concept paper that discusses a proposed idea for more efficient use of en-route airspace, particularly in response to severe weather that materializes differently than predicted (or not at all). There are two linked, dynamic components to the proposal, one for the customer side and one for the ATC side. On the customer side there is a system allowing users to submit a prioritized list of flight options (containing 2D route/enroute time/altitude). If users only submit one option, the default response if they're subject to a FCA is to assign ground delay. In addition users can update or add to their priority list for a flight at any time. On the ATC side, controllers have access to interactive, dynamic views of the flight lists for a FCA and can run an algorithm (manually overrideable) to come up with a solution set of flights to bump down to their lower priority options while searching to satisfy the constraints in a way that provides for the greatest overall system good. Also users will be notified with messages of their status updates. This is purely a notional concept at this point which is being explored through operational concepts and benefits studies by the Future Concepts of Flow Management sub team of CDM.

[43] Peter Kuzminski and Stephen Welman. Demand management and air transportation: An examination of congestion pricing. Technical Report MP01W0000080, The MITRE Corporation, April 2001.

KEY: kuzminski:mp01

ANNOTATION: The authors make the distinction between congestion pricing, peak-load pricing, and traffic targets in terms of the resulting level of traffic, difficulty of implementation, and basis for the toll. Congestion pricing has a toll based on the negative congestion externality produced by each flight. The result is the socially efficient level of congestion at an airport, however it is difficult to implement due to the abstract nature of the costs. Peak-load pricing has the toll based on the efficient allocation of airport operating and investment costs based on the level of demand for the airport's services. The result is a more efficient level of congestion due to the cost allocation based on use. Traffic targets have a toll set to whatever amount is necessary to keep traffic below the desired level. This also results in a more efficient outcome as congestion is controlled through the desired levels. Both peak-load pricing and traffic targets are easier to implement than pure congestion pricing mainly because the costs are more clearly defined. Due to this the authors conclude that congestion pricing is impractical due to implementation details, but something like peak-load pricing or traffic targets could be a viable option for demand management.

[44] Qian Liu and Garrett van Ryzin. Strategic capacity rationing to induce early purchases. Technical report, Columbia Business School, 2005.

KEY: vanRyzin:cbs05

ANNOTATION: The main research question they pursue is whether it is optimal for a firm to create a rationing risk by deliberately understocking products. In other words some customers will buy early at high prices, and prices drop over time to induce more sales. In the ATM environment we want to flip this trend around (offer lower "prices" for early filing of flight plan). One modeling aspect they mention, but do not include, is strategic interaction among customers. The importance of including this in the model depends on the number of customers involved, and there are lit references to papers that do this. Other modeling considerations are capacity constraints and rationing, risk preferences of customers, and whether to use price or quantity as the main decision variable. This paper uses quantity as the main tactical variable, and therefore is less applicable to my work and most papers that involve dynamic pricing and strategic customers that use price as the main variable. The key concept of this work are the tradeoffs for the firm between the benefits of inducing early

purchases at high prices and the cost of lost sales in later periods (rationing risk). Likewise the tradeoff from the customer's perspective is between price and risk of not getting the product.

[45] Mott MacDonald. Study on the impacts of the introduction of secondary trading at community airports volume i report. Technical report, European Commission, November 2006.

KEY: macdonald:ec06
ANNOTATION: Contains a good overview of the issues surrounding airport slot trading as well as secondary trading in other sectors.

[46] Raymond H. Myers and Douglas C. Montgomery. *Response Surface Methodology: Process and product optimization using designed experiments*. Wiley Series in Probability and Statistics. John Wiley & Sons, Inc., second edition, 2002.

KEY: myers:rsm02
ANNOTATION: If we go with an RSM theme for the exam maybe a chapter or two from here can be used for the fundamental concepts.

[47] A. R. Odoni. *New Concepts and Methods in Air Traffic Management*, chapter Congestion Pricing for Airports and for En Route Airspace, pages 31–44. Transportation Analysis Series. Springer, 2001. ISBN 3540416374.

KEY: odoni:cp01
ANNOTATION: Congestion pricing can be an alternative or complement to administrative slot allocation, but in the U.S. would be an alternative since schedule coordination is considered anti-competitive. This would also be most effective at airports with non-homogenous traffic.
Landing fees are generally computed with a target revenue for the year, forecast total weight of the aircraft to use the ap for the year, and the landing fee per unit weight is set as the ratio of the two. There is a disconnect between costs and revenue that could be severe (large ac could pay 60x the fee but occupancy is not that much longer proportionally). Also note that some European aps have begun scaling landing fees up to 50% more for peak times, but there is political opposition to this in the US.
The theory of congestion pricing is that optimal use is achieved through a toll equal to the marginal external cost associated with any prospective user. Using a queueing theory result,

$$MC(i) = \frac{dC}{d\lambda_i} = c_i W_q + c\lambda \frac{dW_q}{d\lambda_i}$$

where MC is the marginal congestion cost, C is the total expected delay cost, λ_i is the demand rate from users of type i, c_i is the cost per unit time for users of type i, c is the expected delay cost per unit time for all users, and W_q is the expected queueing time per customer. However, demand changes too rapidly for the equilibrium conditions to be met. There are some good numerical approaches, but you still must understand the elasticity of ap demand with respect to landing fees. (This ties in as motivation for what I'd like to do with ADL data.)
Most of the opposition to congestion pricing has been political, particularly from the classes of users (GA and regionals) that can least afford to compensate others (and are more sensitive to congestion tolls). Ap neighbors and environmental groups are typically supportive of the idea. Other technical challenges include developing a simple, stable price structure, dealing with large differences in capacity between good and bad weather, enforcement of access times, and reconciling (and not overcollecting) congestion fees with respect to revenue targets. They also introduce an example scenario of a system for BOS in this context.
Their proposed approach for dynamic congestion pricing of enroute airspace involves the ATM provider setting a schedule of charges based on demand forecasts for the day, the users are informed about the charges, users can modify their flight plans to maximize individual welfare, and the ATM provider can revise their fee schedule based on the new demand schedule or the evolution of traffic during the day could cause a revision. This process can then be iterated over the course of the day. The key challenges to actually implementing this include:

- ATM providers have very little knowledge of the user utility functions necessary to anticipate user response to different fee schedules.
- Users' decision making with respect to fees and routes depends on predicted enroute delay, but this is a function of what other competing users do as well, which they're not going to know.
- Modeling of airspace delays is less advanced than modeling runway delays since the queueing theory developments do not hold up as well, so only very approximate estimates are possible

So until these challeges are overcome, only static congestion pricing schemes should be considered.
Note that the CDM Colloborative Routing (CR) effort is something I need to stay on top of as it's a middle ground and in some ways a preliminary step towards airspace congestion pricing. Key elements that we need are the utility functions for selecting a flight route.

[48] Eric Pels and Erik T. Verhoef. The economics of airport congestion pricing. *Journal of Urban Economics*, 55:257–277, 2004.

KEY: pels:jue04
ANNOTATION: This paper introduces some of the key differences between the bulk of the literature which is in road congestion pricing (i.e. link-based) and their current focus on airports (node-based). There are additional differences from pure congestion pricing including the market power of airlines, the share of congestion costs that are internalized, and the strategic interaction between competitors in an oligopolistic setting resulting in non-competitive pricing. The authors also mention in the lit review of airport applications the work of Daniel and how his simulation results show congestion pricing causing a redistributing of demand throughout the day and an environment where smaller aircraft may reroute to alternate airports. This is the type of effect we would be looking for with the airspace so Daniel's work may be applicable.

[49] Marianne Raffarin. Congestion in European airspace - a pricing solution? *Journal of Transport Economics and Policy*, 38(1):109–125, January 2004.

KEY: raffarin:jtep04
ANNOTATION: This paper begins with a review of the current EUROCONTROL pricing rule (square-root of weight, distance flown in area, unit rates). The unit rates for each country are determined each year based on costs and forecasted traffic. This current rule was established in 1971 when congestion was not as much of an issue and its main assumption that small aircraft and short flights have high price elasticity compared to large aircraft and long flights is outdated and no longer valid as well. Among the other criticism of the current rule is there is no incentive for ATC providers to control their costs (as they get it back from unit rates anyways), it does not include an airspace complexity component (not linked to costs), and it provides incentive to use more frequent small aircraft (which increases the congestion involved with moving the same amount of people). The author also develops the current rule theoretically using Ramsey-Boiteux pricing. Next a new ATC pricing rule is proposed that includes incentives to reduce congestion (albeit implicitly by penalizing the frequency of flights). In the development of this rule a sequential game between ATC and two airlines is used that seeks airlines' equilibrium choices that are also socially optimal. As the result of this rule ATC offsets part of the higher airline costs associated with large aircraft and less frequent flights. The pricing rule depends on the external cost by flight, which leads to internalization of the negative effects of too much flight frequency on the total 'social surplus' (i.e. social optimum). In addition this pricing rule is inversely proportional to the aircraft size. This is purely a theoretical paper with a lot of economic theory and fomula developed but no actual data.

[50] Jeffrey B. Schamburg and Donald E. Brown. A generalized multiple response surface methodology for complex computer simulation applications. In R .G. Ingalls, M. D. Rossetti, J. S. Smith, and B. A. Peters, editors, *Proceedings of the 2004 Winter Simulation Conference*, pages 958–966, Washington, DC, December 2004.

KEY: schamburg:wsc04
ANNOTATION: Notes are in a separate file.

[51] Joshua Schank. Solving airside airport congestion: Why peak runway pricing is not working. *Journal of Air Transport Management*, 11:417–425, 2005.

KEY: schank:jatm05

[52] Itai Sened and William H. Riker. Common property and private property: The case of air slots. *Journal of Theoretical Politics*, 8(4):427–447, 1996.

KEY: sened:jtp96
ANNOTATION: Looks very relevant to the common pool stuff.

[53] Hanif D. Sherali, Raymond W. Staats, and Antonio A. Trani. An airspace-planning and collaborative decision-making model: Part i–probabilistic conflicts, workload, and equity considerations. *Transportation Science*, 37(4):434–456, November 2003.

KEY: sherali:ts03

[54] Hanif D. Sherali, Raymond W. Staats, and Antonio A. Trani. An airspace-planning and collaborative decision-making model: Part ii–cost model, data considerations, and computations. *Transportation Science*, 40(2):147–164, May 2006.

KEY: sherali:ts06

[55] Philip J. Smith, C. Elaine McCoy, and Charles Layton. Brittleness in the design of cooperative problem-solving systems: The effects on user performance. *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans*, 27(3):360–371, May 1997.

KEY: smith:smc97
ANNOTATION: You can have automation and the display interaction will impact the use of it.

[56] Xuanming Su. Inter-temporal Pricing with Strategic Customer Behavior. *SSRN eLibrary*, October 2006.

KEY: su:ssrn06
ANNOTATION: This paper includes a lit review that could be helpful including categories of strategic customer behavior, price dynamics, and limited capacity. Their analysis breaks the customer base into 4 categories dependent on the customer attributes of patient or impatient, and high value or low value. Their main research questions involve the interplay between firms' pricing strategies and customer purchase strategies. They also explore when customers delay purchases and wait for sales, does this hurt or benefit the seller, and how.

[57] Kalyan Talluri and Garrett van Ryzin. Revenue management under a discrete choice model of consumer behavior. *Management Science*, 50(1):15–33, 2004.

KEY: talluri:ms04

[58] Amos Tversky and Daniel Kahneman. Judgement under uncertainty: Heuristics and biases. *Science*, 185(4157):1124–1131, September 1974.

KEY: tversky:sci74
ANNOTATION: Three common heuristics that are used for making judgements under uncertainty are presented, along with systematic biases that frequently result from their use.
Representativeness
- bias1: insensitivity to prior probability of outcomes
- bias2: insensitivity to sample size
- bias3: misconceptions of chance
- bias4: insensitivity to predictability
- bias5: the illusion of validity
- bias6: misconceptions of regression

Availability
- bias1: biases due to the retrievability of instances
- bias2: biases due to the effectiveness of a search set
- bias3: biases of imaginability
- bias4: illusory correlation

Adjustment from an anchor
- bias1: insufficient adjustment
- bias2: biases in the evaluation of conjunctive (overstatement) and disjunctive (understatement) events
- bias3: anchoring in the assessment of subjective probabililty distributions

[59] William Vickrey. Congestion theory and transport investment. *American Economic Review*, 59(2):251–260, May 1969.

KEY: vickrey:aer69

[60] Thomas W. M. Vossen. *Fair Allocation Methods in Air Traffic Management*. PhD thesis, University of Maryland, 2002.

KEY: vossen:umd02
ANNOTATION: This work centers around the handling of arrival slots related to GDPs and in particular discusses methods for allocating them among multiple users in an equitable way. The most interesting part of this as it relates to my work is the quantification of fairness as it relates to pursuing ATM objectives (Chapter 4). In addition I am interested in how the class of capacity allocation schemes he develops might be useful in the en-route environment, particularly if they are incorporated with user incentives.

[61] Thomas W. M. Vossen and Michael O. Ball. Slot trading opportunities in collaborative ground delay programs. *Transportation Science*, 40(1):29–43, February 2006.

KEY: vossen:ts06

[62] Stephen Welman and Kathryn Aitkenhead. Demand management of airports: A review of techniques and international trends. Technical Report MP01W0000114, The MITRE Corporation, June 2001.

KEY: welman:mp01
ANNOTATION: This work was done as part of a study on Airports and Airspace System Planning for the Sao Paulo Region, Task 3. This is largely a survey paper of a handful of market based pricing approaches at airports including peak-load pricing, congestion pricing, targeted traffic levels, and multipart tariffs. Multipart tariffs are simply a combination of pricing mechanisms (e.g. a flat operations charge, plus a weight-based charge, plus a peak-load charge at certain times of day). This is also a way of handling different user classes efficiently. The authors also discuss direct pricing at an airport and a futures market for capacity rather thana guaranteed contract for a slot.

[63] Leonard A. Wojcik. *Models to understand airline and air traffic management authority decision making interactions in schedule disruptions: from simple games to agent-based models*, chapter Handbook of Airline Strategy. McGraw-Hill, 2001.

KEY: wojcik:has01
ANNOTATION:

[64] Leonard A. Wojcik. Airline personalities and air traffic flow management: A simple agent-based model. In *4th Aviation Technology, Integration, and Operations (ATIO) Forum*, Chicago, IL, 2004. American Institute of Aeronautics and Astronautics.

KEY: wojcik:atio04
ANNOTATION:

[65] Lee C. Yang and James K. Kuchar. Performance metric alerting: A new design approach for complex alerting problems. *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans*, 32(1):123–134, January 2002.

KEY: yang:smc02
ANNOTATION: Kuchar's work shows that there should be a match between the algorithm and the environment for which it is designed. I'm not sure if this is the most relevant of his papers, check with Bass.

[66] Yafeng Yin and Yingyan Lou. Dynamic tolling strategies for managed lanes. In *Proceedings of the 86th Annual Meeting*. Transportation Research Board, January 2007.

KEY: yin:trb07
ANNOTATION: The authors consider two approaches for dynamically varying the tolls, i.e. feedback control and sequential learning of willingness to pay. In the feedback control approach the tool rate in time $(t+1)$ depends on the toll in time t plus a parameter times the difference between the desired occupancy and the measured occupancy in time t $[\beta(t+1) = \beta(t) + \kappa(o(t) - o^*)]$. For the sequential learning approach (also called reactive self learning), given a toll rate the user's decision whether to pay to gain access is formulated as a logit model. The flow rate before/after choice and the travel times are measured or estimated. This revealed-preference data is then used to recursively estimate the parameters of the logit model. The optimal toll is set based on detected flow and the calibrated willingness to pay. Kalman filtering is used for an online (real-time) estimation of the coefficients for homogenenous users with the same williness to pay. Will heterogeneous users that have distinct willingness to pay characteristics, this technique would estimate the means of the coefficients. Note, I think this would be okay since it's not like they're going to charge users differently even if they did know the different rates. The toll is set to minimize the maximum difference between the actual and desired inflow to the managed lane (based on keeping it close to capacity by not congested). Their results show that the self-learning approach performs better than feedback control. Limitations of the work are the myopic view of both approaches which could cause sharp fluctuations in prices. Also the solution is uncoordinated with other entry points downstream which can lead to equity issues, so this is an area for future work. Note that Patek might have some ideas about this.

[67] Dan Zhang and William L. Cooper. Revenue management for parallel flights with customer-choice behavior. *Operations Research*, 53(3):415–431, May 2005.

KEY: zhang:or05
ANNOTATION: The main research question addressed here is how to select booking limits at each fare class when the airline has many ”parallel” flights between an OD pair in a short time period. Customer preferences between the times are going to be important in how to handle prices, and I am interested specifically in how they take advantage of those preferences in pricing. Their customer choice model is determined by a preference mapping of options to an ordering of those options for each customer, and this information is combined with the inventory availability in decision making. The bulk of the paper involves a Markov Decision Process (MDP) such that the decision variable of the number of seats in a particular flight and booking class are determined only using information on the current state of the system at that time (i.e. a Markovian policy). This decision considers the maximum expected revenue obtainable given demand and the number of seats aviable.

[68] Dan Zhang and William L. Cooper. Pricing substitutable flights in airline revenue management. Technical report, University of Minnesota, 2006.

KEY: zhang:umn06
ANNOTATION: This paper contains a good literature review that could be helpful for me including not just RM papers but choice modeling work as well.