

**OM 386 Pricing & Revenue Optimization – Fall 2009**  
**Unique number 04105**  
**UTC 4.102**

**Professor Sridhar Seshadri**

Time: 3:30– 5:00 MW  
Office Hours: MW 11 am or by appointment

**Course Description:**

Pricing and revenue optimization --or revenue management as it is also called-- focuses on how a firm should set and update pricing and product availability decisions across its various selling channels in order to maximize its profitability. A familiar example comes from the airline industry, where tickets for the same flight may be sold at many different fares, the availability of which is changing as a function of purchase restrictions, the forecasted future demand, and the number of unsold seats. The adoption of such systems has transformed the transportation and hospitality industries, and is increasingly important in retail, telecommunications, entertainment, financial services, health care and manufacturing. In parallel, pricing and revenue optimization has become a rapidly expanding practice in consulting services, and a growing area of software and IT development.

Through a combination of case studies, lectures, and guest speakers the course will review the main methodologies that are used in each of these areas, discuss legal issues associated with different pricing strategies, and survey current practices in different industries. The ultimate goal is for students to learn to identify and exploit opportunities for revenue optimization in different business contexts. As the ensuing course outline reveals, most of the topics covered in the course are either directly or indirectly related to pricing issues faced by firms that operate in environments where they enjoy some degree of market power. Within the broader area of pricing theory, the course places particular emphasis on *tactical optimization of pricing and capacity allocation decisions*, tackled using *quantitative models* of consumer behavior (e.g., captured via appropriate price-response relations), demand forecasts and market uncertainty, and the tools of *constrained optimization* -- the two main building blocks of revenue optimization systems.

**Textbook**

Recommended: Pricing and Revenue Optimization by Robert L. Phillips, ISBN: 0804746982.

Additional readings will be provided in the case packet and Blackboard. Purchase the case packet at the GSB Copy Center.

## Course deliverables

Apart from class participation (20% of the total grade), the other course deliverables consist of a set of homework assignments (40%) and a project (40%).

- Class participation: I will assign a case or topic for each class to one or two groups. You will be expected to start the discussion and present the issues as well as possible solution approaches. This will contribute to part of your participation grade.
- There will be four (4) homework assignments that should be done individually.
- Extra credit: Please post items of interest related to pricing and revenue optimization on Blackboard to obtain up to five points in extra credit.
- There is a course project, which can be done in groups of up to 4 students. Projects should study a specific PRO problem or opportunity faced by a real organization. You are free to choose a topic of your interest. The end goal is to demonstrate the use of pricing and revenue optimization techniques learned in class in a real setting.
- As broad guideline for these projects, put yourself in the shoes of a consulting team trying to help their client to analyze a particular issue that they face that is related to the content of this course. Your study should hopefully culminate with an assessment of the magnitude of the associated PRO opportunity and a blueprint of how to move forward with developing a PRO solution. This could roughly follow the following outline:
  - a. Understand and describe application setting: industry overview, PRO question, what's currently done, etc.
  - b. Describe what is the PRO opportunity and why
  - c. Try to make a quantitative assessment of the potential value of applying a PRO solution to your proposed setting (cf. TNG case discussed in session 17)

In attempting to address the above questions it is useful to think of a model that one would want to use in practice: what data do you need, what are the optimization decisions, how will they be implemented, etc. This model will be useful in demonstrating the potential quantifiable benefits of your proposal. Access to real data is preferred for this last step, but this may or may not be easy to have depending on the company involved. This is a fairly optimistic set of goals given the timeline of this course, but still serves well in structuring your work.

- The deliverables are a project report, in power point format, and an in-class presentation. The timeline is as follows:
  - Session 5: 1-page proposal is due (by email) describing the topic, team, specific goals, and proposed project plan.
  - Before session 10: Meet with me to discuss your proposal.
  - Session 10: Revised 1-page proposal is due (by email).
  - Session 16: 1-page progress report is due.
  - On session 25: each team should meet with me for 30 min to discuss projects
  - Session 27: in-class 20 min presentation (power point) and final project due (we may need to schedule extra time for presentations)

## **Detailed course outline (the exact sequence will be determined after I confirm dates with guest speakers)**

This is a new course and the area of revenue management is still 'hot', hence a lecture on this topic will, for the time being, always be a work-in-progress. While the topics that we will cover and their emphasis will follow what I describe in session 1, I might make small changes to the syllabus along the way (with advance notice).

The speaker line-up is still not finalized and, moreover, some of the placeholders on the syllabus may move around a little. Please make sure you come to class when we have a speaker, and that you come on time.

One Session below is planned for 80 minutes, but I am flexible and prefer that you understand the concepts that we discuss in depth rather than rushing through the material just for the purpose of staying with my outline. Your feedback in this process is valuable, and motivates continuous course improvement. Please do not hesitate to let me know, throughout the course, how I can improve the course and the learning experience it provides!

### **Class 1**

#### **a) Introduction**

Introduction and structure of the course. What is pricing and revenue optimization? History of PRO. Multi-pricing in the airline industry.

Read: Background and Introduction (Ch. 1 of Phillips)

### **Class 2**

#### **Review of Price Theory**

Capturing consumer surplus via differential pricing: personalized pricing, group pricing. Pricing with capacity constraints.

Skim: The Pricing and Revenue Optimization Process (Ch. 2 of Phillips)

Download and Read: What price Vertigo?

- Read through Chapter 2 of Phillips quickly, but be sure you understand what is meant by *the pricing waterfall*, and that you know the three "pure" approaches to pricing listed in section 2.3.
- Read "What price Vertigo?" Be ready to discuss q. 1, and prepare a solution for q. 2 using Solver.

### **Class 3**

#### **Market Segmentation with Differential Pricing**

Market segmentation; versioning; bundling.

Read: Cambridge Software Corp. (HBS Case in *case packet*)

Skim: Versioning: The Smart Way to Sell Informatin (Shapiro and Varian) (in *case packet*)

Background: Chapter 4 of Phillips

Download: Problems on bundling

- If Cambridge Software is obliged to launch just one product, which one should it be, and how should it be priced?

- If several are allowed, which should be launched, and how should they be priced? (It is potentially hard to find the optimal product and price menu. Try to at least think about the following question: what should be the optimal product prices if CSC decides to offer the “student” and “industrial” versions of their software?)

#### **Class 4**

##### **Quantitative models of consumer demand**

Models of consumer demand; Reservation prices; Aggregate demand models; Discrete choice models.

Download and Read: Personal training at the NY Health Club: Part A  
 Skim: Phillips section 3.1 (you may skip over the more technical parts)

- Read through the NYHC case and prepare answers for questions 1 and 2

#### **Class 5**

##### **Consumer choice models (fitting data to models)**

Discrete choice models; The Multinomial-Logit (MNL) model; How to fit MNL model parameters with maximum likelihood estimation; How to deal with censored demand data?

Download and Read: Personal training at the NY Health Club: Part A  
 Skim: Phillips section 3.2

- Read through the NYHC case and be prepared to discuss questions 3 and 4

Note: You may like to compare conjoint analysis and MNL.

*Hand In: 1-page proposal for your group project describing the topic, team, specific goals, and proposed project plan (by email).*

#### **Class 6**

##### **Dealing with Censored Demand Data**

Download the write-up and data on the Multiplex Cinema House sales. Prepare to discuss how to determine demand from the sales data.

#### **Class 7**

##### **Value Based Pricing**

Read: Atlantic Computer: A Bundle of Pricing Options (HBS Brief Case 2078). (HBS Case in *case packet*)

Atlantic Computer, a leading player in the high-end server market, has detected a marketplace opportunity in the basic server segment. They have developed a new server, the Tronn, to meet the needs of this segment. In addition, they have created a software tool, called the ‘Performance Enhancing Server Accelerator,’ or PESA, that allows the Tronn to perform up to four times faster than its standard speed. The central question revolves around how to price the Tronn and PESA. Although cost-plus, competition-based, and status quo pricing are the most common means by which firms establish prices for their offerings, these approaches may prevent firms from fully realizing the benefits that are due to them. Provides an opportunity to optimize value capture for the firm by utilizing value-in-use pricing (i.e., examining the

value that a firm's offering creates for the customer, and using the savings generated as the basis for developing prices). Also allows for the exploration of the challenges surrounding the implementation of a value-in-use pricing strategy. These include the reactions of competitors, customers, and stakeholders within the firm. Please read the case and be prepared to discuss it in class. The following questions can serve as guideline for your case analysis, but please make sure not to answer them point by point in your report:

1. What price should Jowers charge DayTraderJournal.com for the Atlantic Bundle (i.e., Tronn servers + PESA software tool)?
2. Think broadly about the revenue implications from each of the four alternative pricing strategies. Approximately how much money over the next three years will be left on the table if the firm were to give away the software tool away (i.e. status quo pricing) versus utilizing one of the other pricing approaches?
3. How is Matzer likely to react to your recommendation?
4. How is Cadena's sales force likely to react to your recommendation? What can Jowers recommend to get Cadena's hardware-oriented sales force to understand and sell the value of the PESA software effectively?
5. How are customers in your target market likely to react to your recommended pricing strategy? What response can be provided to overcome any objections?

### **Guest Speaker to be announced**

### **Class 8**

#### **Pricing as Constrained Optimization**

Read: Pricing with Constrained Supply (Ch. 5 of Phillips book)  
Download: Pricing Problems with Capacity Constraints

- Using Solver, prepare solutions for questions 1 & 3 from Pricing Problems with Capacity Constraints
- Section 5.5 of Phillips discusses the important modeling issue of *diversion*, which we have already seen in the NYHC case; skim through Problem 7 at the end of the chapter, which serves to reinforce this material through a different demand model approach than the one pursued in the previous session.
- Sections 5.5 and 5.6 merit your careful attention: the theme park example developed in section 5.5 is representative of an important application domain, and section 5.6 describes variants of peak-load pricing that are economically important in other industries.

### **Class 9**

#### **Customized Pricing**

Read: Customized Pricing (Ch. 11 of Phillips book)  
Download: Fjord Motor Customized Fleet Pricing Case and spreadsheet

- Prepare solutions for the questions posed at the end of Customized Fleet Pricing, using data in the file Fjordmotor.xls; at a minimum try to answer problems 1 and 2.

*Hand In: Individual assignment -- Solutions to Fjord Motor (problems 1 and 2).*

### **Class 10**

#### **Markdown Management**

Read: Retailer: A Retail Pricing Simulation Exercise (Broadie and van Ryzin)

Skim:            Markdown Management (Ch. 10 of Phillips book)  
                    Before Christmas, Wal-Mart was stirring (NYT, Jan 2005)

Download:        The *Retailer* game and its data file (detailed instructions below)

- You may want to browse through the website of Profitlogic, the leader in retail markdown management services (i.e., provider of analytical software and consulting services in this area) at <http://www.profitlogic.com/index.htm>.
- Instructions related to the simulator called *Retailer* begin on page 7 of the assigned reading. Read pages 7-9 carefully, trying to infer the structure of the model that underlies the simulator (note particularly the footnotes on page 8).
- Download the data file *Retailer.xls* and, heeding the suggestions offered on pages 8-9 of the assigned reading, analyze this data to extract the information needed to formulate a markdown strategy. (An artificial element of this exercise is that all the items included in the historical data had a list price of \$60, which happily is the list price for the item to be considered in the simulation.) Before starting the simulation exercise itself, work out at least a crude markdown strategy based on your data analysis, again paying careful attention to the suggestions offered on pages 8-9.
- Now download the zip file *Retail.zip* to a new folder called "Retail." Extract all files into this folder and play five iterations of the *Retailer* game, following the strategy you have formulated. (To get started, double click on *Retailer.exe*, the icon that contains a dollar sign. To begin an iteration click (Re)Start on the menu bar. With a little experimentation it should become clear how the mechanics work.) Come to class prepared to discuss your results, the reasoning behind your strategy, and any second thoughts you may now have about that strategy.

*Hand In:*        1. Revised 1-page proposal for your group project (by email)  
                    2. Individual assignment -- Solutions to NYHC Part B; please submit assignment.

## **Class 11**

### **Discuss Markdown Pricing**

### **Introduction to Dynamic Programming**

## **Class 12**

### **Dynamic pricing**

Download:        Retail pricing optimization with uncertain demand

Try to prepare answer to questions 1 and 2. This assignment centers on the subtle and difficult idea of "backward induction," also called "recursive optimization" or "dynamic programming." Answer as much as you can, and think hard about the ones that stump you.

Read the article *How to Reap Higher Profits with Dynamic Pricing* by Arvind Sahay, MIT Sloan Management Review, reprint 48415, Summer 2007, Volume 48, No 4, 53-60. (download and read in Blackboard)

Pick up problem set for submission in Class 7.

## **Class 13**

### **Forecasting Demand**

Look at the Hotel Forecasting Data available on Blackboard. The data in this file concern reservations and registrations for one-day stays at the hotel's highest daily rate (one of many "rate products" that the hotel sells). The meanings of the various data entries are explained by the heading at the top of the file and the

explanatory note at the end. Be prepared to propose one or more common-sense methods, and at least one more sophisticated method, to forecast the number of room registrations for that same rate product on Monday, December 17, 2001. Think first of how to generate a point estimate, then how to generate a probability distribution.

#### **Class 14**

Download and Read: Priceline case

Try to follow how a combination of forecasting and dynamic programming tool is used to price hotel rooms. Go to Priceline's website and examine the method used. Be prepared to discuss the implications for customers, hoteliers and Priceline.

#### **Class 15**

##### **Review of Linear Programming**

We will review how to formulate, solve and understand the output of linear programs in this session. This is preparation for the next three sessions.

#### **Class 16**

##### **Capacity Control via Linear Programming**

Download: Westbrook Hotel and  
Capitol Airlines

- Prepare solutions for the Westbrook Hotel and Capitol Airlines problems.

*Hand In:* 1. 2-page progress report on your group project is due (by email)  
2. Individual assignment -- Submit answers to problem set assigned.

#### **Class 17**

##### **Case Study on Capacity Control**

Download and Read: Transportation National Group (TNG)

- What challenges does TNG face in managing its leases of trailers?
- What is your assessment of TNG's current lease performance measures and controls, especially its use of ROI measures?
- How might TNG implement revenue management? What ideas or approaches seem most viable in a business like this?
- Use linear programming (Solver) to answer the following question: based on the data for the Yakima branch (file TNG.XLS on the course website), what is the potential revenue opportunity at this location from optimally controlling the availability of leases of various durations?
- If TNG wanted to implement revenue management, what recommendations would you make going forward, and how would you prioritize your recommendations?

#### **Class 18 Revenue Management in the Reverse**

***I shall introduce an application of these ideas to purchasing rather than selling.***

*Hand in:* I will introduce a B2B pricing example. Submit your individual solution to the problem at the beginning of Class 19.

## **Class 19**

### **Capacity Control with Demand Uncertainty**

Booking limits and protection levels. Critical fractile solution of the static allocation problem with two fare classes. Nested booking limits and dynamic booking control; introduction to overbooking.

Read: Introduction to ... Yield Management (Netessine and Shumsky), pp. 34-39 (In Blackboard)  
Revenue Management & Capacity Allocation (Ch. 6 & 7 of Phillips)

Download: Football Stadium Booking Control

- Prepare solutions for Problems 1-4 in Appendix B of the Netessine-Shumsky article, and be prepared to discuss them in class.
- Prepare solutions for the two questions posed in Football Stadium Booking Control, and come prepared to discuss them in class.
- The last third of this class session will treat the mechanics of dynamic booking control, specifically in an airline setting, discussing the elaborate systems that have been built around a few relatively simple formulas for determining booking limits. We will discuss the game Easyprofit in this session.

## **Class 20**

### **Yield Management in Casinos**

The principles of Revenue Management we have discussed so far are in practice often interwoven with many other business activities. In this session we discuss the case of Harrah's Entertainment, which implemented a very successful data marketing and revenue management campaign focusing on low roller customers.

Read: Harrah's Entertainment, Inc. (HBS Case 9-502-011) (Harvard case in *case packet*). This case describes a situation facing Philip Satre, chairman and CEO of Harrah's Entertainment, Inc. Satre was reading a May 2000 Wall Street Journal story that discussed the company's marketing success in targeting low rollers, the 100% growth in stock price and profits in the year to December 1999, and the revenue growth of 50%, which significantly outpaced the industry. The exciting articles aroused Satre's desire to know more about the activities of his then COO, Gary Loveman, and his team of 'propeller heads' with respect to their database marketing efforts and the Total Reward Program. Satre was interested in two questions: He wanted to know how much these marketing efforts had contributed to Harrah's overall performance and whether these marketing results were a one-shot event or could be achieved year after year, especially as the competition introduced similar programs. Please read the case and be prepared to discuss the following questions in class:

1. What are the objectives of the various Data Base marketing programs and are they working?
2. Why is it important to use the 'customer worth' in the DBM efforts rather than the observed level of play?
3. How does Harrah's integrate the various elements of its marketing strategy to deliver more than the results of Data Base marketing?
4. What is the sustainability of Harrah's actions and strategy?
5. What are the privacy and ethical issues that Harrah's should be concerned about?

## **Class 21**

### **Yield Management in Airlines**

Rick Elieson, Managing Director, Revenue Management Development Group, American Airlines

## **Class 22**

### **Online pricing**

Read: A Dashboard for online pricing by Baye, Gatti, Kattuman and Morgan, California Management Review, Fall 2007, Volume 50, No. 1, 202-216. (download and read in Blackboard)

## **Class 23**

### **Yield Management in On Air and Online Media Industry**

I will describe work done at RSG Systems Inc on pricing and yield management for the media industry.

## **Class 24**

### **Yield Management Initiatives at IBM**

Dr. Anshul Sheopuri, IBM Smart Planet Initiative, IBM TJ Watson Research Center  
“Dynamic Pricing in Cloud Services, User Charging, etc.”

## **Class 25**

### **Reserved for project discussions**

## **Class 26**

### **Implementation of PRO**

Download and read: Bloomingdale's case study

The main issue in the case is how to measure and quantify the benefits of a pricing optimization system. This was a serious concern facing Bloomingdale's and the case accurately captures the relevant issues. Basically, the question I would like you to consider is this: How should Bloomingdale's use the data from their pilot study to quantify the benefits of the Profitlogic PO system? I would like you to propose an approach for answering this question. You don't have to do a detailed analysis of the data, but I would like you to think through HOW you would approach it and make a concrete recommendation. You may work in groups on this and don't have to turn anything in but I expect you to have given the question serious thought.

## **Class 27**

### **Final Student Project Presentations**

*Hand In: final project report (in power point or word)*

## References

Theory and Practice of Revenue Management, Kalyan T. Talluri, Garrett J. van Ryzin

Revenue Management--Hard-Core Tactics for Market Domination, Robert Cross

*This syllabus has been adapted from that of Professor Costis Maglaras of Columbia University and Dr Joern Meissner of Lancaster University. Sincere thanks especially to Costis for his help in teaching this course over the years.*

Important Topics not covered: IT Systems for PRRO. Ethics of pricing and revenue management. Customer and competitive reactions and acceptance. Organization issues and change management. Pricing strategy.