Teaching Demand Management and Price Optimization in the MBA Program at the Carnegie Mellon University Tepper School of Business

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Tepper Working Paper 2008-E21
Forthcoming in INFORMS Transactions on Education – Special Issue on Teaching Revenue Management
Guest Editor: Ioana Popescu
Submitted: June 2008; Revised: September 2008; December 2008; Accepted: December 2008

Abstract

In this paper, I describe the course Demand Management and Price Optimization that I have taught in the MBA program at the Carnegie Mellon University Tepper School of Business during the past five years. I focus on my experience in teaching this course, which has significantly evolved over time from essentially a revenue management course to a course that emphasizes quantitative models that address features falling at the interface between the operations and marketing functions of a firm. I hope that prospective instructors of similar courses will find this discussion useful and informative in making their own choices regarding how to structure their courses.

1. Introduction

In this paper, I describe the course Demand Management and Price Optimization (DMPO) that I have taught during the past five years in the MBA program at the Carnegie Mellon University Tepper School of Business. This course is an MBA elective that counts both as an operations management course and a quantitative analysis course. DMPO largely started as a “pure” revenue management course, but it has now evolved to feature a broader perspective on the interface between the operations and marketing functions of a firm.

I developed and taught DMPO in academic year (AY) 2003-04 and also taught it in the next three consecutive AYS, from AY 2004-05 to AY 2006-07. DMPO was not offered in AY 2007-08 for idiosyncratic reasons. I will teach it again in AY 2008-09. The MBA program at the Carnegie Mellon University Tepper School of Business includes three types of programs: day-time (regular), flex-time (evening), and flex-mode (remote locations). I have taught DMPO five times in the day-time program and once in each of the flex-time and flex-mode
programs. Thus, I have gained significant experience in teaching DMPO. I will teach one
day-time section and one flex-time section of this course in AY 2008-09.

My goal in this paper is to provide details of my experience that hopefully will be useful
to prospective instructors of similar courses when making their own choices regarding how
to structure their courses. I emphasize how DMPO has evolved over time. Rather than
providing a year-by-year list of the changes that I have made to this course, I offer a more
general description of my approach to teaching DMPO, its content, what seems to work well
and what does not, some challenges, and what I have learned in the process. Parts of DMPO
are still very much in flux, and I have taken the liberty to include in this description also
some topics that I intend to cover when I will teach this course again in AY 2008-09.

The structure of DMPO is related to the Pricing and Revenue Optimization (PRO)
course described by Phillips (2003 [18]), and similar courses discussed by Bell (2004 [2]) and
Dutta (2006 [10]). These courses focus on the optimization of pricing and revenue-related
decisions. DMPO also deals with these topics but has a broader perspective, as discussed in
§2 (see also §6). Thus, a paper describing DMPO seems warranted.

The remainder of this paper is organized as follows. Section 2 discusses the focus and
theme of DMPO. Section 3 describes my choice and the sequence of topics and applications.
Section 4 presents the main elements of the course syllabus and relevant references. Section
5 articulates how DMPO fits within the MBA curriculum at the Carnegie Mellon University
Tepper School of Business. Section 6 compares DMPO against similar MBA courses. Section
7 illustrates some ongoing challenges in teaching DMPO and lessons that I have learned while
teaching it over the years. Section 8 provides some brief concluding remarks.

2. Focus and Theme of the Course

DMPO is an operations management elective. (As mentioned in §1 and discussed in §5,
it also qualifies as a quantitative analysis elective.) Thus, it has an operational focus: the
matching of supply and demand by emphasizing the management of the latter component,
which is inspired by the approach of Cachon and Terwiesch (2006 [6]) to teaching operations
management. However, DMPO differs from their approach because it presents models that
are not fully developed in Cachon and Terwiesch (2006 [6]).

Specifically, Cachon and Terwiesch (2006 [6, Chapter 13]) discuss revenue management
booking limits and overbooking techniques to manage demand when supply exhibits signif-
icant inflexibility. DMPO takes a broader view: in addition to the tools of revenue management, it recognizes that the tools of operations management and marketing, including pricing, can be usefully integrated to match supply and demand.

Here, DMPO borrows from the views of Shapiro (2007 [26, p. 481]) that “Integration of supply chain and demand management decisions should be a prime concern of any profit-maximizing firm.” This author sees much promise in the use of data-driven integrated supply chain management and marketing models to improve a firm’s profitability. In as far as improved profitability reflects a better match between supply and demand, the view of Shapiro (2007 [26]) clearly illustrates the theme of DMPO: the use of data-driven optimization-based demand management models that recognize the firm’s supply choices and considerations (e.g., capacity and inventory availability) as tools to support managers to better match supply and demand, thereby improving profitability in the process.

This theme is reflected in the name of the course. Although price is not the only demand management choice that can be optimized, it does represent an important one in practice; e.g., markdown pricing in retailing (Mantrala and Rao 2001 [16]). Recent supply chain and operations management textbooks, such as Chopra and Meindl (2007 [8]), Simchi-Levi et al. (2008 [29]), and Van Mieghem (2008 [33]), include a chapter on revenue management and pricing that discusses price optimization.

3. Choice and Sequence of Topics and Applications

DMPO covers the following topics: revenue management (booking control), overbooking, price-response functions and constrained supply pricing, markdown pricing, customized pricing, additional joint supply and demand management decisions, and competitive analysis. Phillips (2005 [19]) covers the first five topics, and others, in detail. Shapiro (2007 [26, §§12.1-12.5] provides sufficient material and references for the last two. Following are brief descriptions of the topics covered in DMPO.

• **Revenue management (booking control).** This topic deals with the business situation faced by a firm that sells products to different customer segments of uncertain size at different prices through advanced reservations, and delivers its products by employing finite perishable capacity. It is therefore advantageous for the firm to control the booking of its capacity over time by accepting/rejecting customer orders (capacity reservations). Selling airline seats is the classical example of this situation.
Other applications deal with industries such as car rental, hotel, transportation, and manufacturing.

- **Overbooking.** In the stated revenue management setting, it is commonly the case that a significant number of accepted reservations do not materialize at the time of product delivery. Thus, the firm can improve its revenue generating ability by taking more reservations than its capacity would allow; that is, overbooking. The potential applications of overbooking are similar to those of revenue management.

- **Price-response functions and constrained supply pricing.** The price-response function relates the demand for a given product by a given customer segment during a given time period to the price charged. It is essentially a price-dependent product and customer-segment revenue rate. Different from the revenue management setting, this construct has almost universal business applicability, with application domains including theme parks, sports and entertainment venues, and online advertising. The firm’s objective in the short and medium term is to maximize margin (price minus avoidable costs) from product sales. If the firm’s supply (capacity/inventory) is fixed during the time period under consideration, the firm faces a constrained supply pricing problem. Both in the unconstrained and constrained supply cases, the relevant problem is margin optimization.

- **Markdown pricing.** This topic deals with the special case of constrained supply pricing faced by most retailers. Seasonal merchandise, e.g., apparel, is sold during a relatively short time period during which customers’ valuations naturally decrease as time progresses.

- **Customized pricing.** This topic corresponds to the situation faced by firms that operate in business, as opposed to consumer, markets. In business markets, the norm is that suppliers negotiate individual prices with different customers who perform price comparisons among competing suppliers. Customized pricing aims at setting a price for a specific deal to optimize a supplier’s margin from the transaction while taking competitors’ behaviors into account in a statistical (decision-theoretic) fashion.

- **Additional joint supply and demand management decisions.** This category potentially includes a very large set of topics. I restrict attention to strategic distribu-
tion decisions with revenue and cost considerations, joint production and advertising or dynamic pricing decisions, and product line configuration.

- **Competitive analysis.** This topic deals with pricing at the industry level with competition. It relies on structural (game-theoretic) modeling of competitive behavior. Applications include pricing with competitive effects and pricing in commodity and commodity-like markets.

I have not covered all of these topics in earlier versions of this course. In particular, most of the topics included in the last two categories are new, and I intend to cover them in the next version of DMPO to be taught in AY 2008-09. I admit that the ability to cover competitive analysis within the available time budget is in doubt. Thus, I consider this topic optional.

I present the course topics in the same sequence discussed above. In the remainder of this section, I elaborate on my choice of starting off with classical revenue management, which appears to be rather unusual for a course such as DMPO. The main reason for my choice is simple: No other course outside the operations area in the MBA curriculum covers these topics (they are briefly covered in the day-time core operations course). This is a unique opportunity for me to showcase both why DMPO is different from courses in other areas, in particular, the strategic pricing course in marketing, and the practical usefulness of managing demand while taking supply considerations into account.

In a revenue management setting, the relevant managerial tension is between taking too many “low” price orders too soon and reserving too much capacity for “high” price orders that may not materialize. This tension is captured by the notion of opportunity cost of capacity. Of course, this concept is closely related to the shadow price of capacity that students learn when studying linear programming in their modeling classes (at the Carnegie Mellon University Tepper School of Business this occurs at the very beginning of the MBA program). However, I introduce the opportunity cost concept by using the notion of expected marginal seat (capacity) revenue, without reference to linear programming (I do go back to linear programming when dealing with multiple resources, that is, the so called “network” case), and I further elaborate on it by using dynamic programming.

The disadvantage of this topic sequencing choice is that students may associate DMPO with some of the applications (airlines and hotel) used to illustrate the opportunity cost concept, and may lose interest in this course if they are not specifically interested in pursuing
a career in one of the associated industries. This is an important concern that can be easily addressed. I explain to students that the notion of opportunity cost is relevant in several other settings; e.g., the allocation of manufacturing capacity to customer orders (clearly, due date management is also relevant here). I refer students to Nagle and Hogan (2006 [17, pp. 162-164]), who discuss the relevance of incorporating opportunity cost in strategic pricing decisions; in particular “when costing the use of a manufacturing facility, a railroad right-of-way” in addition to “the seat capacity of an airline.” (Nagle and Hogan (2006 [17]) is the textbook used in the strategic pricing course in the Carnegie Mellon University Tepper School of Business MBA program.)

I also emphasize that revenue management is considered an important tool for gaining customer value in business markets by Anderson et al. (2009 [1, p. 368]), who state that “In business markets, revenue management is particularly useful in such industries as business travel and lodging, and consulting and research [and] can also be used very effectively in business service contexts such as after-sales service of specialized, complex, and expensive capital equipment including semiconductor manufacturing machines, power generation systems, and robotic systems used in manufacturing.” (Anderson et al. 2009 [1] is the textbook of the business-to-business marketing course in the Carnegie Mellon University Tepper School of Business MBA program.) These associations are very beneficial in dispelling the stated concerns and directly connect DMPO to other courses in the MBA curriculum (see also §5).

I proceed by asking students which system computes the opportunity cost of capacity in a typical company. Students have no answer. I suggest that their lack of answer is in fact correct: the typical firm has no such system. I then stress that airlines, hotels, and car rental companies are the most sophisticated firms in consistently computing the opportunity cost of their capacity across markets and time periods, and that although not all companies representing these industries excel at other aspects of doing business, there is a lot to learn from them in terms of effective demand management. This contrast allows students to appreciate the potential practical usefulness of revenue management methods in other business settings.

There is also a direct methodological connection between revenue management and the other DMPO topics that rely on constrained supply pricing: as is well known, the opportunity cost of constrained supply is a component of an optimal price. I use this argument to explain to students that revenue management models using the opportunity cost of capacity
to make accept/reject decisions, such as the bid price method, can be thought of as restricted constrained supply pricing models.

4. Syllabus and References

This section discusses important elements of the DMPO syllabus, excluding the course topics and their sequence presented in §3. I refrain from including my syllabus because it may be too specific to the MBA program at the Carnegie Mellon University Tepper School of Business, which is based on short, seven-week, mini semesters. Moreover, the effective class time available in a mini semester depends on the type of program, day-time or flex-mode/time, with less class time available in the latter cases. This implies that some topics must be covered in less detail or fewer topics must be covered in these cases. However, a typical MBA elective should be able to cover all of the topics, except for competitive analysis, provided that a selective choice of applications is made in terms of the models dealing with additional joint demand and supply management decisions.

With the exception of Bloomingdale’s (Ke et al. 2007 [15]), Fjord (Phillips 2007 [20]), and Retailer (Broadie and van Ryzin 1995 [5]), which I will likely use in AY 2008-09, I have used all of the cases displayed in Table 1. (These cases are either published or available from their authors.) These cases span different topics and applications ranging from revenue management in airline/transportation/hospitality contexts to markdown pricing in retailing and customized and dynamic pricing in manufacturing. Case discussions are interspersed with lectures throughout the course.

The course features the use of simulators. I have used the Easy Profit simulator of Popescu (2006 [22]) once with good success. This is an airline simulator that allows students
Table 2: Videos.

<table>
<thead>
<tr>
<th>INFORMS Franz Edelman Award</th>
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<tbody>
<tr>
<td>American Airlines, 1991: Airline revenue management</td>
</tr>
<tr>
<td>National Car Rental, 1996: Car rental revenue management and pricing</td>
</tr>
<tr>
<td>NBC, 2001: TV advertising slot sale revenue management and pricing</td>
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<tr>
<td>Texas Children’s Hospital, 2003: Hospital contract optimization</td>
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<tr>
<td>Travelocity, 2006: Internet retailing</td>
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<td>Chrysler and J. D. Power, 2007: Automotive industry pricing</td>
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<tr>
<th>INFORMS Society for Marketing Science Practice Prize</th>
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<tr>
<td>CVS, 2005: Retail promotions</td>
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<td>bauMax, 2005: Retail assortment and promotions</td>
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to play the role of a revenue manager of a single flight, whose seats are sold over time to two customer classes. Students like this tool because it makes the potentially abstract concept of revenue management booking limits concrete. I have never used the Retailer simulator of Joneja and Broadie (1994 [14]) in class, but will do so the next time I will teach DMPO. This simulator emulates the process of marking down the price of seasonal merchandise in retailing as the selling season progresses. What I have used so far in this respect is a simplified Excel-based version of this simulator that I developed, which allows me to illustrate in a hands-on fashion how to approach the development of simple, yet effective, decision support models in practice. Of course, these two activities are not mutually exclusive (more on this below).

Support activities include external speakers and videos of effective managerial practices that leverage relevant quantitative models. Students prefer external speakers for obvious reasons. However, videos of the INFORMS Franz Edelman Award competition and the INFORMS Marketing Science Practice Prize competition may provide more variety. Table 2 includes the videos that I have employed during different years of teaching DMPO, with the exception of Travelocity and Chrysler and J. D. Power, which I intend to use in AY 2008-09. The INFORMS Franz Edelman Award videos are available from INFORMS, and are supported by a paper published in the first issue of Interfaces following the year of the Edelman competition (see Table 3). The INFORMS Society for Marketing Science videos are also available from INFORMS and are supported by an electronic copy of the presentation that was given during the competition.

Assessment activities include homework, cases, either a project or a final exam, and participation. I typically assign three homework sets and three cases, which keep students reasonably engaged throughout a mini semester. I recommend having either a project or a
final exam. A final exam stimulates students to take a comprehensive view of the course material. This exam can be in-class or take-home, with the latter alternative creating less anxiety among students. A project is more stimulating than a final exam for most students. However, it has two disadvantages in the Carnegie Mellon University Tepper School of Business mini semester setting: (1) it can be both challenging and frustrating for students to come up with interesting topics and perform a proper analysis in one mini semester; and (2) there is typically no time left for students to present their work in class, which is something they highly enjoy. Another option is to assign students a guided project. That is, assign to students a project dealing with a specific topic whose execution can lead to a (largely) predefined set of outcomes and guide them through the selection of one of these outcomes.

For example, in AY 2008-09 I will likely assign students a retail markdown pricing guided project, based on the data used by the Retailer Simulator (Joneja and Broadie 1994 [14]), and ask them to develop a simple Excel-based simulator that embeds both a demand-forecasting model and an optimization-based markdown model, which allows them to assess the performance of these models. That is, I will ask students to create a simplified Excel-based version of the Retailer Simulator (there are only so many ways to approach this problem). In this “extended exercise,” students would practice how to creatively approach the development of a data-driven forecasting and optimization decision support tool by being guided through the process of conceptualizing, creating, and explaining such a tool in a written report. This approach could reduce the students’ anxiety level associated with executing a full blown project in one mini semester, without compromising their creative experience.

Yet another possibility is to have students present an article that describes an implementation documented in the practice literature. The advantage of this choice is that students practice giving presentations. The disadvantages are that (1) students present someone else’s work without engaging in a creative process in the same way they would in a (guided) project; and (2) one must trade off presentation time with lecturing time; that is, the number of topics that can be covered in the course decreases. One way to tackle the second disadvantage would be to ask students to prepare a written report, but this would take away the excitement of giving a presentation, which is more important for this type of assignment than for (guided) projects.

Graded participation stimulates active student involvement. However, as in any other MBA course, it is difficult to measure.

Table 3 displays the readings of DMPO. I adopted the book by Phillips (2005 [19]) one
Table 3: Books, articles, and journal.

<table>
<thead>
<tr>
<th>Books</th>
<th>Articles</th>
</tr>
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<tbody>
<tr>
<td>Phillips (2005 [19])</td>
<td>Fleischmann et al. (2004 [11]): Pricing and operations management</td>
</tr>
<tr>
<td>Shapiro (2007 [26, Chapter 12])</td>
<td>Smith et al. (1992 [31]): Airline revenue management</td>
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<td></td>
<td>Geraghty and Johnson (1997 [13]): Car rental revenue management and pricing</td>
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<td></td>
<td>Friend and Walker (2001 [12]): Retail markdown pricing</td>
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<tr>
<td></td>
<td>Mantrala and Rao (2001 [16]): Retail markdown pricing</td>
</tr>
<tr>
<td></td>
<td>Smith et al. (2007 [30]): Internet retailing</td>
</tr>
<tr>
<td></td>
<td>Bollapragada et al. (2002 [3]): TV advertising slot sale revenue management and pricing</td>
</tr>
<tr>
<td></td>
<td>Born et al. (2004 [4]): Hospital contract optimization</td>
</tr>
<tr>
<td></td>
<td>Silva-Risso et al. (2008 [28]): Automotive industry pricing</td>
</tr>
<tr>
<td></td>
<td>Robinson and Satterfield (1998 [25]): Profit-based distribution strategy</td>
</tr>
<tr>
<td></td>
<td>Yunes et al. (2007 [35]): Product line configuration</td>
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</table>

*Journal of Revenue and Pricing Management*

year before it was published. I have found that some students do well without the book by relying on my slides. However, some students prefer to have a book for reference. In the next version of DMPO, I will also include §§12.1-12.5 of the book by Shapiro (2007 [26]) in the course readings to provide students with reference material on additional joint supply and demand management decisions.

The course readings also include several relevant articles selected from Interfaces, Harvard Business Review, MIT Sloan Management Review, and the OR Practice area of Operations Research. Further, they include a link to the Journal of Revenue and Pricing Management via our university’s library website. This journal includes several interesting articles dealing with pertinent applications. I have found it to be a good resource for students. (It would also be a good source for project ideas.)

I conclude this section by discussing two “must have” topics and related teaching material:

- **Revenue management**: Capacity control with a network of resources based on the demand-to-come linear program and the related bid price method with transportation applications, the Transportation National Group case (van Ryzin 1998 [34]), and the article by Smith et al. (1992 [31]).

- **Prize optimization**: Single-item markdown pricing in retailing, the Retailer simulator (Joneja and Broadie 1994 [14]) and case (Broadie and van Ryzin 1995 [5]), and the
articles by Mantrala and Rao (2001 [16]) and Friend and Walker (2001 [12]).

In addition, Fleischmann et al. (2004 [11]) is a concise and informative executive level article that discusses both of these topics.

The common denominator between these two topics is that they are both based on real applications. Moreover, the two highlighted cases can both be solved using linear programming. Thus, these two topics could be used as the content of a module on revenue management and price optimization focused on the application of optimization methods to support demand management decisions. Such a module could be part of an operations management or operations research course.

5. Fit in the Curriculum

DMPO plays an important role in the operations offerings in the Carnegie Mellon University Tepper School of Business MBA program. It is one of the “Level I” electives in operations management (a “Level I” elective is a course suggested to students who wish to concentrate in operations management); the others are courses on supply chain management and quality. This positioning of the course is a very recent development, and attests to the practical relevance of managing the “revenue and demand side” of firms in conjunction with the management of their “cost and supply side” and the quality dimension.

The applications of optimization, probability, and statistics play important roles in DMPO. Thus, this course also qualifies as a quantitative analysis course in the Carnegie Mellon University Tepper School of Business MBA program. All the students who enroll in DMPO are well versed in operations research, probability, and statistical modeling and analysis; e.g., they are all familiar with how to formulate and solve optimization models in a spreadsheet. This is due to the fact that the Carnegie Mellon University Tepper School of Business MBA program features required quantitative courses that students take in the two initial mini semesters of their first year and before enrolling in the core production and operations management course, which is the prerequisite for DMPO. Instructors whose MBA programs might not feature required quantitative courses would have to compensate for possible heterogeneity in the students’ quantitative modeling and analysis skills by providing short and very focused introductions to these topics.

By its very nature, DMPO bridges our MBA operations and marketing offerings. As mentioned in §3, two courses are directly connected to DMPO in terms of topics: strategic
pricing and business-to-business marketing. However, these courses are more qualitative than DMPO, which thus serves a complementary function. In particular, the strategic pricing course covers pricing and customer segmentation strategies, which are not part of the material covered in DMPO, and does not feature the same depth of quantitative modeling and analysis of DMPO. Moreover, the former course has a strategic focus while the latter course has a tactical and operational focus.

There is also a connection between DMPO and the negotiation course offered in the organizational behavior area. The basic principle of the latter course is that a negotiator should not agree to a deal that brings him/her a benefit that is below the value of his/her best alternative to a negotiated agreement (BATNA; Raiffa et al. 2003 [24]). Although this makes perfect sense, it is less clear how a commercial negotiator can systematically estimate his/her BATNA value. The notion of opportunity cost discussed earlier is relevant here: the opportunity cost can be useful in estimating one’s BATNA value in a commercial setting. Moreover, when pricing decisions are relevant, an optimal price should typically exceed the opportunity cost. These arguments make for a good class discussion.

The topics covered in DMPO give rise to several interesting ethical questions. Phillips (2005 [19, Chapter 12]) discusses some of these issues. Although I do not have enough time to address these aspects in DMPO, they make excellent teaching material for ethics. One way to introduce some of this discussion in the course is to enlist an outside expert to address these aspects as part of a case study discussion. At the Carnegie Mellon University Tepper School of Business, we are very fortunate in this respect because Professor John Hooker has made himself available for this purpose. The amazing part of this is that John is both the T. Jerome Holleran Professor of Business Ethics and Social Responsibility and a Professor of Operations Research, which is a perfect match for the stated purpose.

Finally, the course is indirectly related to courses in the area of corporate finance. The link here is that different demand management choices can impact the firm’s working capital. The models presented in DMPO do not deal with this link in an explicit manner. A case study dealing with this topic would be extremely useful.

6. Comparison with Similar Courses

Few other business schools offer full MBA courses similar to DMPO. I am aware of the following such courses:
• *Dynamic Pricing and Revenue Management* taught by Ioana Popescu at INSEAD (http://faculty.insead.edu/popescu/rm/). Apparently, this was the first such course to be developed and taught in a business school (it was offered as early as 1999).

• *Pricing and Revenue Optimization* taught by Costis Maglaras at the Columbia Graduate School of Business.

• *Price and Revenue Optimization* co-taught by J. Michael Harrison and Robert Phillips at the Stanford Graduate School of Business. This course is offered in both short (7 weeks) and long (14 weeks) versions.

• *Pricing and Revenue Management* taught by Itir Karaesmen at the Robert H. Smith School of Business, University of Maryland. As the previous course in this list, this course is also offered in two versions: short (8 weeks) and long (16 weeks).


Moreover, modules dealing with revenue management are included in operations research or operations management courses in various MBA and executive MBA programs. Bell (2004 [2]) and Dutta (2006 [10]) document two such examples.

An examination of the syllabi of the referenced full courses reveals that there are two main differences between these courses and DMPO: (1) the sequencing of topics (with the exception of the short course at Stanford), and (2) the positioning of the course.

First, all but one of these courses follow the basic structure of the course outlined by Phillips (2003 [18]). That is, they deal with pricing and price optimization aspects before dealing with revenue management (capacity allocation and booking control) and overbooking; however, not all of these courses deal with overbooking. For the reasons discussed in §3, DMPO does the opposite. The only other course that uses the same order of topics’ presentation of DMPO is the short version of the Stanford course. It is interesting to point out that the full version of this course does not follow the same structure. In contrast, both the short and the full versions of the Maryland course use the same sequencing of topics. Thus, the length of the course does not seem to be a useful dimension to explain the inversion of the order of topics’ presentation in the Stanford short course.

Second, DMPO is positioned as an operations management elective at the interface of operations and marketing that also features a quantitative content. In other words, although
it does qualify as a quantitative elective, this course is fundamentally an operations management course that deals with demand management tools to support operations managers in matching supply and demand (see §2). In our MBA program, this aspect is reflected in DMPO being one of three “Level I” operations management electives (see §5). In contrast, although some of the referenced courses are taught by operations management faculty, it seems fair to state that these courses emphasize the application of operations research and statistical techniques to support a set of demand management business processes rather than directly positioning the course as a fundamental element of operations management education. Even though our MBA program is fairly quantitative in nature, and DMPO is no exception, this remains an important distinction.

This is illustrated by the inclusion in DMPO of the following topics (see §3): joint supply and demand management decisions and competitive analysis (even though I have never covered the latter one because of time limitations). In this respect, DMPO is related to those operations management courses that include a revenue management module. (Recall from §2, that most of the newer operations management MBA textbooks include a chapter on revenue management, pricing, or demand management; see, e.g., Cachon and Terwiesch 2006 [6], Chopra and Meindl 2007 [8], Shapiro 2007 [26], Simchi-Levi et al. 2008 [29], and Van Mieghem 2008 [33].) The difference between DMPO and these courses is one of emphasis: while these courses emphasize supply management decisions and touch on demand management decisions; DMPO emphasizes demand management decisions and touches on supply management decisions.

7. Challenges and Lessons Learned

Teaching DMPO comes with challenges. One challenge is related to the possible previous treatments of revenue management in the core operations management course. Students in our day-time program are exposed to some revenue management concepts. This is both a blessing and a curse. The positive aspect is that some students are already familiar with the basic idea behind revenue management. Thus, some of those enrolled in DMPO want to deepen their understanding and knowledge of the relevant issues. The negative aspect is that some students may be satisfied with their exposure to revenue management in the core course and do not enroll in DMPO, thus negatively affecting enrollment (discussed below). Of course, this is not all bad because it is likely that these students would not have enjoyed
Table 4: Enrollment by AY and program type.

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Program Type</th>
<th>Enrollment</th>
<th>Average</th>
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<tbody>
<tr>
<td>2003-04</td>
<td>Day-time (Section A)</td>
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<tr>
<td></td>
<td>Day-time (Section B)</td>
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<td>2004-05</td>
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<td>Flex-time</td>
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<td>Flex-mode</td>
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<tr>
<td>2008-09</td>
<td>Day-time</td>
<td>30&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flex-time</td>
<td>30&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>30</strong></td>
<td><strong>Grand Average = 27</strong></td>
</tr>
</tbody>
</table>

<sup>a</sup>Preregistration figure

Enrollment can be a challenge if one must meet minimum class size constraints. Table 4 shows that enrollment in my course has varied significantly over time, also as a consequence of the reduced class size of the day-time program in AY 2004-05 (but this should change soon). On average, the course has attracted 27 students per section that was offered. Restricting attention to the day-time program, this reduces to roughly 24 students per section, which is about 15% of our typical day-time MBA class size for the years considered. Preregistration for the Fall 2008 courses is up to about 30 students in each of the two sections being offered. This is encouraging given that DMPO had not been offered in AY 2007-08. Compared to an elective on supply chain management, enrollment in DMPO is roughly 25% smaller. It is also important to mention that although DMPO has so far attracted only a relatively small fraction of the MBA student population, I have received very positive feedback from the students who have taken this course.

The quantitative orientation of the course can be a challenge, not so much because the content is too technical for students, but rather because some students may be carried away with models. The real challenge is to present models for what they are; that is, tools that can potentially improve decision making. Although this is a challenge for any quantitative course in an MBA curriculum, it may be more relevant for a course that spans both operations and marketing because models that address issues in two functional areas are more difficult to use and implement in practice. Thus, it is important to structure this course to address
specific issues that arise at the interface of these functions in concrete settings.

This need for specificity and concreteness is itself a challenge because the more well
developed tools are in traditional areas of applications such as airlines, hospitality, and
retailing. Focusing exclusively on these areas makes students question the relevance of the
course beyond these settings, but venturing into other areas where the practice of quantitative
demand management and pricing is not well established goes against the stated need for
concreteness. This requires open communication by the instructor to properly set students’
expectations. Inviting external speakers involved with nontraditional applications can also
be useful in this respect because it can serve the purpose of illustrating the state of the art in
a particular area of application. Moreover, exploratory follow-up project courses with teams
of MBA students could be used to identify relevant issues in novel areas of application.

I learned several lessons in teaching DMPO. This course clearly originated from within
the revenue management community of professionals and academics. However, most students
have never heard of revenue management, unless they have worked for an airline, a large hotel
chain, or a car rental company or have been exposed to it in the core operations management
course (differently from our day-time students, our flex-mode/time students are not exposed
to revenue management in the core operations management course). Thus, some may think
that it is an area of accounting related to earnings management, while others may be simply
unclear as to what a revenue management course has to offer (despite the course description
that is made available to them). A more contextual name for the course that is different
from revenue management is a better alternative. I thank Professor J. Michael Harrison for
raising my awareness of this issue.

Different alternatives do exist. I like having demand management in the title because it
contrasts with supply chain management. I also like having optimization in the title because
it sends a clear signal about the quantitative orientation of this course. At this stage “price”
is part of the course name, but one could replace it with “revenue” to express that this course
emphasizes revenue maximization, as opposed to only cost minimization. Instructors at other
institutions have opted to combine price, revenue, and optimization in a single title, such
as PRO; that, however, leaves out “management” and emphasizes the “operations research”
features of the course. In a nutshell, my strong suggestion to prospective instructors is to
opt for a name more descriptive than Revenue Management for their course.

Another lesson I learned is related to the fact that most MBA students, as future man-
gragers, like to solve problems. As academics with a quantitative orientation, we like to develop
and analyze models that we believe are useful in solving business problems. Most MBA stu-
dents with a quantitative bend have a different perspective: they like to use models as an
aid to solve business problems. This is an important distinction. My job as an instructor of
DMPO is not to convince students that the models I am presenting to them will exactly solve
their business problems. Rather, it is to explain to them how they could use these models
to their advantage, knowing that they are perfectly aware that models are a simplification
of reality. The lesson learned here is that I can openly discuss the limitations of the models
I teach with my students. Students appreciate this position and enjoy discussing how to use
or adapt a model to their particular needs.

The last lesson I want to emphasize relates to the assessment activities. One may be
tempted to structure them around group assignments of case studies and a project. This
may work well if groups are very cohesive. However, this is not always the case. Thus, making
a significant part of an individual student’s grade depend on his/her own involvement with
the course material becomes important to ensure that significant learning occurs on the
part of every student enrolled in the course. Although this issue arises with every MBA
elective, it is particularly relevant for a course that features quantitative models that can
only be understood if a student spends some time by him/herself applying the model to
solve specific problems. Individual homework sets or a final exam are useful to achieve this
outcome. I did not use these assessment activities in the first two years that I taught this
course, but I have always used them thereafter.

8. Conclusions

This paper describes my own experience in teaching DMPO to MBA students at the Carnegie
Mellon University Tepper School of Business. It covers aspects related to the focus and
theme of this course and my choice and sequence of topics and applications; it provides the
main elements of the course syllabus and relevant references; it articulates how DMPO fits
within the MBA curriculum at the Carnegie Mellon University Tepper School of Business;
and finally, it discusses some ongoing challenges in teaching DMPO and lessons that I have
learned over time while teaching this course.

I would like to conclude this paper by encouraging other instructors to develop their
own courses dealing with similar topics, or at least by developing related modules to be
included in a core operations management/research course. My advice to prospective in-
structors is that an open mind and willingness to learn are required to happily embark in this endeavor. Teaching this course is challenging and stimulating, and I have always found it to be extremely rewarding.

Acknowledgments

I thank the guest editor, Ioana Popescu, an anonymous associate editor, and two anonymous referees for their constructive criticism that helped me to improve the content of this paper. I also thank J. Michael Harrison, Itir Karaesmen, Costis Maglaras, Robert Phillips, and Baohong Sun for sharing with me the syllabi of their courses.

References


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