The "Killer Application" of Revenue Management: Harrah's Cherokee Casino & Hotel

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Abstract

Harrah’s Cherokee Casino and Hotel is an extreme and unusual example of revenue management techniques. Typical revenue management installations yield revenue enhancements of 3-7%. Harrah’s, chainwide, has seen 15% improvements, with Harrah’s Cherokee Casino and Hotel perhaps the most excessive beneficiary, despite serving no alcohol and having no traditional table games. Further, many traditional revenue management techniques are turned on their heads: For example, pricing decisions and customer segmentation rules are different for casinos than in virtually any other revenue management application.

It's a typical Thursday summer night at the reservations office of Harrah's Cherokee Casino & Hotel (hereafter referred to as "the Cherokee"): 183 of the 576 rooms are still unreserved for tomorrow night. A returning customer calls.

Customer: "I'd like to reserve a room for tomorrow night."

Operator: "May I have your Total Rewards number?"

Customer: "10701319246."

This number identifies the customer as Joe Smith. Historically, Joe Smith bets an average of $2,000 per night. Probabilistically, this means the Cherokee will net $140 profit on Mr. Smith's gambling alone.

Operator: "Sorry, Mr. Smith, all the rooms at the Cherokee are booked. Would you like me to make you a reservation at the Ramada? The room will be complimentary, of course."

For those who have studied revenue management (RM), Mr. Smith's reservation attempt contains several unusual aspects. Mr. Smith has been turned away from the Cherokee, even though 183 rooms are not currently reserved, and it is the night before the event. Further, Mr. Smith received a free room somewhere else. The Cherokee's RM system predicts that these decisions contribute to the profitability of the hotel.

In other industries, RM systems have increased revenue 3-7% (Cross 1997). The RM system at Harrah's has increased revenue per room across the hotel chain by 15% (Underwood 2003). A specific estimate for the Cherokee is not known, as the Cherokee began life with a RM system in place, but we suspect it is greater still. While many gaming properties are financially successful, the Cherokee sets a standard: It

returns a 60% profit margin on gross revenue, double the margin of the industry norm (Smith 2006).

RM applications in the gaming industry have received some attention in the academic literature – Talluri and van Ryzin (2004 p. 559) briefly mention its application and Hendler and Hendler (2004) and Kuyumcu (2002) explain the theory of how it should be accomplished and the difficulties of implementation. While the Cherokee has a state-of-the-art RM system, describing innovative RM algorithms is not the purpose of this work. Rather, our goal is to showcase the success and value of the most extreme application of RM. Indeed, the Cherokee represents the "killer application" of RM.

Revenue Management in Casino Hotels

RM systems in casinos are different than RM systems in other industries. Gambling causes differences in approach to the issues of pricing and customer segmentation. Further, the extreme difference in customers' willingness-to-pay compared to other applications is the engine that drives the extra profitability.

Pricing

The purpose of RM has been defined as "selling the right capacity to the right customer at the right price" (Smith, Leimkuhler, and Darrow 1992). For now, let us accentuate "price."

The top graph on Figure 1 depicts traditional price setting from Economics 101: A market clearing price P_0 occurs where supply and demand curves meet. The shaded region above the price point and below the demand curve represents "consumer

surplus," or the difference between what a consumer would pay and the amount they have to pay. A main concept in RM is setting differential prices for homogenous capacity. That is, for capacity that looks the same to the outside observer, such as a coach class seat on an airplane or a standard hotel room, a goal is to find a way to get those who would pay more to do so. The typical RM approach is depicted in the middle graph. Several prices are set, here P_0, P_1 and P_2, and consumer surplus is only gained by the consumer in the shaded regions above each price point. Consumers who are willing to pay more than P_1 for the service are no longer paying just P_0. Setting appropriate prices is a difficult and crucial aspect of traditional RM.

Price setting in gambling, however, doesn't really occur. Each customer sets their own price – the amount they wish to gamble. In that sense, given *N* standard hotel rooms, there are *N* different amounts of revenue the casino derives from customers using undifferentiated capacity as depicted in the bottom graph of Figure 1. In this sense, consumer surplus is entirely ceded to the producer.

******Put Figure 1 about here******

Segmentation by Restriction

The middle graph on Figure 1 depicts an ideal situation for RM: In this graph, all those who are willing to pay above price P_2 pay P_2, and all those who are willing to pay above price P_1 pay at least P_1. In reality, many who are willing to pay a high price find a way to pay a lower price. A basic problem of RM is how to enforce differential prices for the same service. Typically, prices are enforced by restrictions. For the airlines, a typical restriction is how far in advance one books a flight, and whether a Saturday stay-

over occurs during the trip. Business travelers who are less concerned about price also tend to book very close to the day of departure and tend not to want to stay over a Saturday, whereas leisure travelers that are more price conscious tend to book well in advance and stay the weekend.

However, segmenting by restriction has many downsides. Some restrictions are simply against the law. "Ethnic pricing" of airfares – charging different prices based on nationality – is a common practice elsewhere, but illegal in the U.S. (Mitchener 1997). More common problems include segment accuracy. The business travelers who can plan in advance or are willing to stay over a Saturday get the cheaper airfares, even if they would have paid top dollar. Customers also avoid paying top dollar by finding ways, some creative, some too creative, to circumvent the rules (see Metters, et al. 2006, p. 251 for examples). Another problem with segmenting restrictions is negative customer perception and loss of goodwill. Casinos, however, have no need to create such restrictions because customers segment themselves. This lack of artificial segmentation is an advantage for RM operations.

Willingness-to-Pay

RM decisions in casinos have a greater impact than RM decisions in other industries. This is due to a large differential in customer willingness-to-pay. For those who are receiving standard hotel rooms, the top casino gamblers may lose several thousand dollars per day versus other customers who may lose $50 per day. Thus, the highest paying customers are willing to pay 20 to 50 times what the lowest paying customers will pay. On the other hand, the highest paying airline coach class

customers may only be willing to pay 3-5 times more than the discount customers, and the highest paying standard hotel room in a non-casino hotel may pay merely double the discount rate. Consequently, the opportunity cost of filling a room with a low paying customer versus a high paying customer is much larger for casinos, and the differential in customer willingness to pay makes improving RM decisions very profitable. With this general casino background, we now turn to a discussion of the Cherokee in particular.

Cherokee Property Description and Background

The 13,000 strong Eastern Band of Cherokee Indians owns and operates Harrah's Cherokee Casino and Hotel. Harrah's and the Eastern Band agreed to open the hotel, with Harrah's sharing less in daily operations and profit over time.

The Cherokee casino itself is different from a typical casino because of its goals and competition. Like other casinos, a goal of the Cherokee Hotel is profitability; unlike other casinos, profits are used to better the life of the immediate Cherokee Indian community. Instead of returning profits to stock holders, the Cherokee casino returns profits to Cherokee tribe community funds. These funds support all tribe members and specifically aim to support better healthcare, education, and other initiatives to increase the tribal standard of living. Because of the community-centered end goal, management makes some uncommon casino decisions.

Due to decisions made by the tribe, the casino does not serve alcohol and prohibits entry to patrons who notify the Cherokee that they have a gambling problem. Due to negotiations between the tribe and the state of North Carolina, the Cherokee has no table games, such as roulette, craps, and poker. There are no dice and no physical

playing cards at this casino. The blackjack and baccarat games are electronic – the dealer pushes a button and the image of a card appears on the players' screen. In addition to these unusual circumstances, the Cherokee's location provides challenges as well.

The Cherokee Hotel is located in the town of Cherokee in rural western North Carolina. It draws a large number of its customers from the Atlanta, Georgia metro area, a three-hour drive away, in addition to other metro areas throughout South and North Carolina and Tennessee. There are no direct competitors to the Cherokee for hundreds of miles, giving the Cherokee something of a natural monopoly. However, the Cherokee recognizes that their customers can easily fly to Las Vegas, or any other gambling location, which serves alcohol and provides poker, roulette, and craps tables.

The Cherokee contracted with Harrah's Entertainment to manage their casino. Harrah's is the largest gaming company in the world and has a history of bringing advanced mathematical analysis to the gaming industry. A former Harvard Business School professor, CEO Gary Loveman, has published articles regarding the pioneering use of analytic techniques at Harrah's (Loveman 2003) and other service organizations (e.g., Loveman 1998). Many articles in the popular press have also extolled the virtues of Harrah's analytic approach to the industry (e.g., McGinn 2005, Schlosser 2004, Underwood 2003). As noted in a Stanford business school case written about Loveman and Harrah's, "Loveman believed that there was an opportunity to apply science to the gambling business" (Chang and Pfeffer 2003, p.7). It is this analytic approach that has allowed the Cherokee to become so profitable.

Harrah's Cherokee casino opened for business in November 1997. In 2002, a 252 room hotel was opened. The hotel was expanded to 576 rooms in 2005. The hotel now has 88,000 square feet of gaming space and 3,400 gaming devices, as well as several restaurants and meeting spaces.

The 576 rooms of the Cherokee are not enough. January through November, weekdays and weekends, the Cherokee averages 98.6% occupancy. Hotel stays at the Cherokee are only extended to its very best customers. However, the Cherokee has so many good customers that it purchases blocks of rooms at neighboring hotels for the second tier of customers.

Let us restate some pertinent facts: The Cherokee is a three hour drive from its target market, offers no alcohol or physical, tangible table games, yet has a 98.6% occupancy rate. It returns a 60% margin on revenue to the Cherokee tribe. Truly, this is an unusual property. Exhibit 1 provides the key tasks involved in the majority of hotel RM systems. In the following sections, we provide more details on what exactly occurs in each of these tasks that makes the practice of RM at the Cherokee so unusual.

******Put Exhibit 1 about here******

Observing Customer Behavior

The middle graph on Figure 1 illustrates an idealized, perfect version of assigning customers to segments in a typical RM situation. So, too, the bottom graph on Figure 1 depicts a Utopian version of RM at a casino. If *N* rooms are available, how can a system be devised to say "yes" to the *N* most profitable customers that wish to book that evening, while declining the bookings of all other customers?

For Harrah's the answer starts in their customer tracking program. Harrah's system is based on the "Total Rewards" card program, which tracks customers' wagers. Before playing an electronic game, customers enter their card in the gambling device and the card tracks their play electronically, recording the amount each customer wagers. For the electronic table games, the customers present the card to casino employees, who note the average wager and duration of play.

Unlike the loyalty cards of some other industries, Harrah's customers have a strong incentive to use their Total Rewards card. The Cherokee gives complimentary or reduced price rooms, meals, casino chips, valet service and other perks and amenities to those who have more tracked play. The more a customer spends gambling, the more the hotel gives them. There is a potential weakness here, as some potentially high profit customers do not have Total Rewards cards, but the odds are with the Cherokee, as 83% of the money wagered is "tracked" play. Here, Harrah's is able to leverage its size. Harrah's is the largest gaming company in the world, and the Total Rewards system tracks 27 million people, and 76% of gambling revenue is tracked to specific customers (Binkley 2004).

Free rooms are the rule, not the exception, at the Cherokee, where 98.6% of the rooms from January to November – and nearly 100% during most weekends – are complimentary, driving the average room rate to about $6/night. This seems odd in the hotel industry, where traditional hotels try to increase their per-room revenue, not decrease it. The difference is that at Harrah's, "revenue" means a customer's total spend – including food, gambling, and hotel room. On average, guests at the Cherokee "pay" $565/night, even though their room may be free of charge.

This tracking system has benefits beyond room reservation decisions. Many Cherokee gamblers either stay at another hotel in town, or are just on a day trip. For those that don't stay at the hotel, there are still incentives for using Total Rewards cards. The Cherokee monitors gambling in real-time so that if a customer loses a lot of money, employees will give them a free $5 or $10 voucher to help them change their luck. Also, gambling during a given time period automatically enters patrons into random drawings for prizes or cash while in the casino. Because of these and other incentives, customers have an incentive to use their reward cards everywhere in the casino. Due to the customers' compliance, the casino knows how people gamble, and can track how marketing initiatives affect that gambling pattern, giving them the information needed to improve each initiative.

In addition, the Cherokee tracks each individual machine's total customer spend by the time of day. By tracking which machines are most popular, the casino can put these machines farther into the casino, knowing that patrons will seek them out and spend money at other machines along the way. The casino constantly tracks overall casino layout, and compares machine spend at one layout versus another to refine and optimize traffic flow. This information can also be used to encourage guests to stay a little bit longer (and spend more). For example, if the Cherokee sees that people start leaving around 2:00 pm on a Sunday, they may announce a random drawing for 3:00 pm to encourage people to stay an extra hour.

This tracking differs significantly from traditional casino practice. Casino staff have always pampered their big spenders. However, a knowledgeable employee tracked each big spender on a personal level, and the tracking was done on a more

informal basis so that precise customer spend was unknown. Further, the designation of a customer suited for special treatment could be due to employees singling them out because they are big tippers, or personal friends, rather than truly being revenue producers for the company. Traditionally, casinos only tracked the truly big spenders, the "whales." Harrah's created the idea of tracking even the small fry; and found, to the surprise of many experienced casino managers, the mid-tier customers were very profitable. Other casinos have similar customer loyalty programs. An innovative aspect of Harrah's Total Rewards program is that they actually use the data in a formal sense to inform their RM system.

Customer Segmentation

The Total Rewards program assigns a specific value to each customer. There is no need to group customers into segments like "business," "leisure" or other designations for the purpose of pricing – the customers self-price by gambling, and the casino gives away the rooms for free. However, for the sake of visually seeing the data and ease of forecasting, it is useful to segment customers into discrete groups.

Table 1 shows the customer segmentation scheme. This visual display creates an environment easier to manage. Mathematically, it might be optimal to close out rooms to customers whose expected profit is under $379.25, and hold open an extra 10 rooms for customers whose expected profit is between $627.39 and $745.67. However, managerially, it is more effective to visualize the data in customer segment format. The Cherokee uses ten customer segments based on expected gaming losses. Expected gaming losses are found by multiplying historical "coin-in" – the amount of money

wagered – by the house percentage. For the purposes of segmentation it doesn't matter whether a customer actually wins or loses money, just how much money the customer gambles. The highest gambling segment used by the Cherokee is CS0: Patrons in this segment have an expected gambling loss of over $1,000/night. Correspondingly, CS1 patrons have an expected gambling loss between $800-$999/night. This proceeds down to the lowest level gamblers in segment CS8. Segment CS9 is for potential customers who are not in the database.

******Put Table 1 about here******

System operators see a more complex version of Table 1 for customer segmentation forecasts and bid prices. Figure 2 shows the main recommendation screen that operators view. For confidentiality reasons, this is a screen shot of another unnamed hotel that uses the same software. The main portion of the screen contains the same information that exists in Table 1. The left banner of the screen shows the status of each day in an 8 month horizon. Clicking on any particular day calls up the data pertaining to that day. While the demand forecasts are refreshed daily, bid prices and computer generated recommendations can be recalculated at any time by the operator. The software also has modules for group sales.

******Put Figure 2 about here******

Like nearly all RM segmentation schemes, the customer does not see this segmentation. Typically, a business must hide its segmentation scheme from customers to avoid having customers take advantage of the system. For example, consider a hotel customer who is willing to pay the "rack" rate – rack rate being the undiscounted, highest rate paid at the hotel for that room. If that customer gains

knowledge that a customer in a different segment can purchase the same room for a lower price, two events may occur: the customer attempts to convince hotel staff they are in that different segment, or the customer becomes angry and goodwill is lost.

A unique aspect of RM in the gaming industry is that the customers' motives are aligned with the segmentation scheme, rather than misaligned. The customer does see a segmentation scheme at the Cherokee, just not the precise one in Table 1. The Total Rewards cards have three levels: gold, platinum and diamond. A customer earns larger perks and discounts, including preferred seating at restaurants and exclusive promotions, with each successively higher level. Customers attain higher rewards levels by gambling more money; the hotel earns higher profits when customers gamble more money. Hence, the customer and the firm have aligned incentives within the RM system.

Forecasting Demand

The room allocation process starts with forecasting "unconstrained demand" for each of the market segments. "Unconstrained" refers to a forecast of *true* customer demand for a service. Like other RM applications, the forecast for today's demand is based on comparable historical data. For example, the forecast for this Friday would be based on what happened the previous few Fridays and what happened on a similar date last year. In many RM applications, the true demand for prior events is not known – what is known is only how many people were given reservations. The Cherokee tracks those who were denied reservations by customer segment to get a clearer picture of true demand. They are able to do so because customers provide their

Harrah's Total Rewards number when attempting to get a reservation. The majority of the Cherokee's bookings occur through their own call centers and web pages although a small percentage of occur through third-party channels such as Travelocity, Expedia, and Orbitz.

While the Cherokee can capture customer denials when the customers book through their own channels, they are unable to capture this data when the customers book through the third-party channels. Therefore, the Cherokee must unconstrain the demand data from the third-party sites. They do so by using a simple method. Assume that for a given customer segment, the Cherokee allows 20 bookings through their own channels but observes a total of 25 booking requests (5 customers were denied bookings). Thus, total demand for this segment was 125% of the booked demand. Now assume that for the same night's stay, 4 bookings were taken through the third-party sites but no denied requests were recorded. To unconstrain the demand data from the third-party sites, the RM system will multiply the 4 recorded bookings by 125%, resulting in a total of 5 booking requests. Thus, the total unconstrained demand recorded for this segment on this night's stay will be 25 + 5 = 30.

Note that this unconstraining method is not recommended for properties that do not take a large percentage of their bookings through their own channels as extrapolating the percentage of denied bookings to a much larger sample can lead to significant errors. Most other hotel chains and airlines fall into this second category. For these firms, there are other unconstraining methods which are more suitable, a review and performance test of which are provided in Crystal et al. (2007a).

After unconstraining historical demand, the Cherokee applies a forecasting algorithm similar to a Holt-Winters smoothing model. The forecast includes smoothed values for base demand, demand trends, annual and day of the week seasonality, and special event factors. A forecast is created for every customer segment and every day in the booking curve. For example, $F_{i,t}$ represents the forecast for customer segment i that is t days into the booking curve. If the booking curve is monitored for 90 days before arrival and there were no seasonal or special event effects, then $t = 1, \ldots, 90$ and the forecasting model would just be a double exponential smoothing model predicting a curve similar to the one shown in Figure 3. Seasonality and special event effects are present however so the forecast must be adjusted accordingly. Each of these effects is included in the forecast by multiplying their "smoothed" coefficient with the original base and trend component, similar to the Holt-Winters smoothing model. Thus, the forecasting model takes the general form:

$$F_{i,t} = (Base_{i,t} + Trend_{i,t})(Seasonal\ Month_{i,t})(Seasonal\ Day_{i,t})\ (Event_{i,t})$$

As an example of how the forecasting model works, suppose we are forecasting demand for customer segment 2 for a Thursday night stay in April and there is a special event scheduled for this night where a new car will be given away. The forecast we are most interested in is the total demand for customer segment 2 throughout the booking horizon, i.e. $F_{2,90}$. If we are presently only 10 days into the booking curve, then we extrapolate the cumulative demand out to the entire 90 day booking horizon using double exponential smoothing. Thus, if the base component at $t = 10$ is 5 and the trend component is 1.5 customers per day, then the base + trend forecast for total demand will be $5 + 1.5(90 - 10) = 125$. Now suppose that demand in April is lower than average

so the monthly season coefficient is .87, the demand on Thursdays is higher than average so the daily seasonal coefficient is 1.05, and the special event coefficient is 1.12 (the free car give away draws 12% more demand than normal). The final forecast for this day and this segment will then be $F_{2,90}$ = (*125*)(.87)(*1.05*) (*1.12*) = *127.9*. All of these factors are updated based on unconstrained demand data from previous booking curves. The forecast can then be manually overridden by management under special circumstances, such as a prediction for severe weather or a special event planned by the competition.

Capacity Allocation

The Total Rewards information system provides helpful information – the historical value of a customer who calls in for a reservation. The segmentation scheme helps by collecting these values into a manageable entity. But the Cherokee still needs a system to decide how many reservations to take from each customer class.

While day-to-day booking decisions are made by hotel staff, the back-office aspects of the RM system at Cherokee are managed by Rainmaker. Rainmaker manages RM systems for many gaming industry properties. The system was initially developed by Talus (now called JDA). In previous corporate incarnations, Talus developed RM solutions for car rental firms (Geraghty and Johnson 1997, Grimes and Carroll 1995), Ford, Hilton, Marriott, TUI, Omni Hotels, Continental Airlines, Sommerfield, and Limited Brands among other firms.

As is typical in RM situations for hotels, the system controls all but the highest value customers and suites. Casino hosts directly book the extremely high value, VIP

customers and schedule all suite bookings. The RM system is used for booking the 547 standard rooms of the 576 rooms in the hotel.

Overbooking and optimization models use the forecasts as inputs to recommend inventory controls – the "constrained demand" in Table 1. The booking recommendation system is, at its core, a linear program. The optimization model is a special case of the price-inventory management model of Kuyumcu and Popescu (2006). The bid price model is updated (or re-optimized) each time one of the following events occurs: a) 24 hours has passed since the last optimization, b) five rooms have been booked since the last optimization, c) the RM analyst manually starts a new optimization (the optimize button on the bottom of the screen capture in Figure 2).

Bid Price Construction

The basic job of any RM system is to determine, at the time of a customer request, whether it is more profitable to meet that customers request which will reduce the available capacity by one unit, or to not sell to that customer in hopes that there will be an opportunity to sell that unit of capacity to a higher value customer in the future, before the product being sold expires. The key to this decision is the calculation of the "opportunity cost" from selling a unit of capacity to the wrong customer. This opportunity cost is typically calculated using the average revenues or profits of the higher value customer segments multiplied by the probabilities a higher value customer will request that unit of capacity in the future.

At Harrah's Cherokee, a customer from a low value segment may be termed a "nickel slotter" because they only average spending around $30 per night; mostly just playing the nickel slot machines. In contrast, a customer from the "high roller" segment

may average spending around $500 per night. Obviously, Harrah's Cherokee prefers to sell a room to a "high roller" customer than a "nickel slotter", but what if a room is available and a "nickel slotter" shows up first? Harrah's Cherokee uses a variation of a bid price control system to determine whether or not to sell this person a room. A bid price system sets a threshold limit for the amount of expected revenue a customer will generate per night. If the customer comes from a segment where the average spend is less than this threshold, the customer is denied a room. If the customer comes from a segment where the average spend is above, the customer is sold a room.

To demonstrate how a bid price control system works, assume for simplicity that a casino only rents rooms for one night stays (this procedure can easily be modified to accommodate multiple night stays but the notation becomes more complex). Also assume the casino segments its customers into K distinct segments. Let r_i represent the historical average revenue that a customer from segment i spends per night at the casino, $i = 1,\ldots K$. Let d_i represent the forecasted total demand for rooms from customers in segment i. The decision variable is X_i, the number of rooms to allocate to customers in segment i. The sum of the rooms allocated to each segment must be less than or equal to the capacity of the casino. Using this notation, the bid price control problem can be formulated as a linear program (LP) as follows:

$$\begin{aligned} \max \quad & \text{Total Revenue} = \sum_{i=1}^{K} r_i X_i \\ s.t. \quad & X_i \le d_i, \quad i = 1,..K \\ & X_i \ge 0, \quad i = 1,..K \\ & \sum_{i=1}^{K} X_i \le \text{ Capacity} \end{aligned}$$

The objective function in the above LP is just the sum of the average revenues per segment times the number of rooms allocated to that segment. The first constraint insures that the number of rooms allocated to a segment does not exceed the forecasted demand for that segment. The second constraint ensures against a negative allocation of rooms to a segment and the third constraint ensures the total allocation does not exceed the capacity of the casino.

An alternative capacity allocation algorithm that factors in demand uncertainty is the EMSR-b algorithm (Talluri and van Ryzin, 2004). Indeed, if the capacity allocations were not updated frequently over the booking horizon, the EMSR-b method would be preferred over the bid price algorithm. The reason is that the bid price model uses expected values for its demand parameters. The use of expected values does not take into consideration the possibility that having less capacity than demand may be more or less costly than having more capacity than demand (by factoring in demand uncertainty, the EMSR-b algorithm includes this situation explicitly). The bid price model, however, compensates for ignoring demand uncertainty by constantly updating the forecast for each customer segment and re-optimizing the capacity allocations accordingly. Because of the frequent forecast updates, the negative impact of ignoring demand uncertainty is minimized the same way that solving a deterministic production planning model on a rolling horizon minimizes the negative impact of ignoring demand uncertainty in a production environment.

While the LP above could be solved directly to determine the exact allocation of capacity for each customer segment, it is more practical to solve the LP and use the resulting “shadow price” from the capacity constraint. The shadow price provides an

estimate for the opportunity cost of reducing capacity by one room. In other words, a potential customer requesting a room needs to bring in more revenue than the shadow price for it to make economic sense for the casino to reduce their capacity by one room. These shadow prices are commonly referred to as bid prices in RM systems. Chen and Freimer (2004) provide a good introduction on how bid price RM systems work at hotels (including multiple night stays) and pages 31-32 in Talluri and van Ryzin (2004) provide some advantages and disadvantages of using bid price controls over alternative RM capacity allocation algorithms.

The bid prices shown in Table 1 are managerial in nature, not just the outputs of an LP. Table 1 includes the level of complimentary services accorded to each customer segment. As a practical matter, hotels do not charge more than their standard rate, even when the LP generated bid prices would indicate that this should occur, as they believe customer reaction would be negative to such a practice.

Table 1 depicts a night when the Cherokee closed bookings to CS5 and below. This level of closure is not unusual. For many weekend summer nights the Cherokee closed reservations at level CS0 (>1,000), and excluded customers with a theoretical profit of $0-$1,000.

Booking Curves

A booking curve shows the cumulative demand for a product from a customer segment from the day the product is first made available to the day of departure (airline) or arrival (hotel/casino). Booking curves for the Cherokee differ substantially from those of other businesses that utilize RM systems. For a typical airline or hotel, demand from

the less desirable customer segments arrives early, while demand from the more desirable customers arrives closer to the departure or arrival date. Airlines only offer deeply discounted international flight seats twenty-one days in advance, and these seats frequently sell out within days. Discounted hotel rooms associated with conferences are often blocked out years in advance. Full coach airfares and rack rate hotel rooms are typically booked a week to a day in advance.

In contrast, the booking curves at the Cherokee resemble the one depicted in Figure 3, which shows a disguised version of a typical weekend night booking curve. For clarity, we show only one customer segment. The x-axis depicts the number of days prior to the date under consideration, with "0" being the day of the arrival. The y-axis shows the cumulative number of rooms reserved. The most striking aspect of the booking curve is the sharp spike as the arrival day under consideration approaches. For this 576 room hotel that will be filled on Friday night, it is not unusual to have only 240 rooms reserved by Wednesday. Approximately 100-120 customers will walk-in without a reservation on a Friday, wanting a room. To a certain extent, a Friday stay at the Cherokee is an impulse item, decided upon while at work on a Friday afternoon. The Cherokee commonly receives reservation requests from guests calling on their cellphones while driving there.

******Put Figure 3 about here******

This sharp spike in the booking curve speaks to an intense need for an RM system. Without a system that will accurately predict demand from more desirable customer classes and reserve rooms for the predicted guests, the temptation would be overwhelming to grant reservation requests from less desirable customer classes.

Another difference in RM between the Cherokee and the more typical hotels is that there's no major difference in the shape of the demand curves between customer segments. The majority of the customers from all the customer segments tend to wait until the day of the event to make a reservation.

The system operator observes a more complex version of Figure 3. Figure 4 shows a screen shot of actual booking curves (again, for confidentiality reasons, Figure 4 depicts a different hotel). The color coded lines emanating in the lower left portion of the screen forecasts for the current day as well as actual results from prior, similar days. The line starting at the upper left portion of the screen is the number of rooms the system is allocating. The number of rooms to allocate changes over time due to overbooking considerations as well as decisions made on groups outside the scope of the system.

******Put Figure 4 about here******

As noted earlier, the occupancy of the hotel is 98.6%. Typically, an occupancy rate this high is indicative of poor RM. The traditional way to achieve high occupancy is to accept all reservations as they come in, which leaves the desirable customers shut out when they try to book later. Best practice RM saves a block of rooms for desirable customers, but because of the stochastic nature of customer arrivals and the inability to accurately forecast, a significant portion of those saved rooms remain unused. Indeed, Rainmaker reports that in a typical gaming application, occupancy will decrease four percent although revenue will increase 17%. The Cherokee avoids this fate because of the nature of their last-minute business and the attendant low no-show rate.

The nature of the last-minute reservations also helps to create a high occupancy rate that does not detract from profitability. For typical airlines and hotels, the discount business books well in advance, and is prohibited from booking at the last minute due to customer segmentation rules. Unfortunately, this process leaves these businesses with empty seats and rooms if the high paying customers do not show up as forecasted. For the Cherokee, however, this is not the case. If it's 8pm on a Friday night, and the predicted high-value customers aren't showing up as forecasted, the lower-value customers can be given a room. It is important to note that the Cherokee's RM system is important for predicting demand because the defined high-value customers vary from season to season. During a busy night (for example, New Year's Eve), there may be enough demand from the two or three highest segments to fill the hotel. For a mid-week stay during a slow season, the hotel may need to book rooms from customers across all classes. The RM system allows the casino to turn away lower customer segments while knowing, with a reasonable probability, that higher value customers will fill those rooms.

The no-show rate and resulting overbooking are essential elements of any RM system concerning hotels. However, the no-show rate at the Cherokee is quite small and predictable, averaging only 7 customers per night Monday-Thursday, and 15 customers on the weekends. Largely, this is a function of the booking curve. No-shows are more likely to occur when a customer reserves a room far in advance, and intervening events cause plan changes. Since the bulk of rooms are reserved on only a few days notice – or while driving to the location – there are far fewer cancellations.

Exhibit 2 summarizes the decision process of the RM system each time a new customer room request arrives (a customer in segment *i* for this example). Each room request updates the forecast regardless of whether or not the request is honored (assuming, as discussed previously, the request does not arrive from a third-party site). For each room request, the customer inputs their total rewards number and the system pulls up the total expected nightly spend associated with this rewards number. If the total expected nightly spend is greater than the current bid price, the customer is awarded a room, else, the room request is denied. The forecast and bid prices are then periodically updated to reflect the new information about demand and capacity.

*****Put Exhibit 2 about here*****

Measuring Revenue Management Effectiveness

A measure of system effectiveness is called the "revenue opportunity index" (ROI) and can demonstrate the extreme need for an RM system in this case.

ROI = (Actual revenue – optimal revenue) / (revenue with no controls – optimal revenue).

ROI is a hindsight measure. The "optimal revenue" is back-calculated based on the number of reservations denied from higher segment groups while reservations were accepted from lower paying segments. Actual numbers are considered proprietary, but the ROI calculation in Table 2 demonstrates the order of magnitude of using an RM system for the Cherokee. The RM system allocates rooms in the same manner as Table 1, and generates $460,650 in gaming revenue that day. The "optimal" column indicates that a few guests who arrived at the last minute were not given rooms. If the system had perfect knowledge of all guests' intentions, then $471,100 could have been

generated. However, consider the case of no RM system. Since there is no tracking of high- versus low-rollers, reservations are accepted on a first-come-first-served basis. Given the booking curves of all segments, this would approximately generate uniform bookings between customer segments. Because no high-rollers are tracked, no complimentary rooms are provided, so each patron pays $125/night for their room. Even with the additional room revenue, the first-come-first-served solution generates only $318,425. The RM system generates 45% more revenue than the first-come-first – served solution. The ROI calculation here indicates that the system could improve another 7%, but the value of an RM system is shown. It costs no more to house 547 high-rollers than a mix of 547 high- and low-rollers, but the results in Table 2 indicates that using an RM system is worth an additional $142,000 in pure profit on this day alone.

******Put Table 2 about here******

Integrating Customer Relationship Management and Revenue Management

The Cherokee integrates their marketing and RM functions so that their Customer Relationship Management (CRM) and RM systems enhance and support each other. For example, if booking data from the RM system suggests hotel traffic will be light on a specific future date, then the marketing group uses the CRM system to select loyal customers who may want to stay at the Cherokee. Marketing sends automated phone calls, e-mail blasts, or outgoing live calls to these targeted customers. These communications promise additional incentives to come to the casino on the specific dates needed. Since the communications are targeted to customers with

known reward numbers, the casino tracks which customers have responded to the marketing initiatives in the past. The casino tracks who responds, how quickly they respond, and which incentives work best, enabling them to continually improve marketing methods for the next time hotel booking curves are behind. More detail on integrating RM and CRM systems can be found in Noone, Kimes, and Renaghan (2003) and Hendler and Hendler (2004).

Implementation Difficulties and Challenges

When an RM system is introduced, employees may initially not trust the system-generated recommendations. The Cherokee opened with a RM system in place that had already been accepted throughout the many Harrah's properties, and the initial Harrah's management team had implementation experience. However, the gaming industry in general does not use RM systems such as the one described. The RM implementation and usage challenges includes issues regarding both people and business processes.

The RM system impacts day-to-day activities of many people; some of them embrace the change and others resist it. For example, casino hosts and personnel that book wholesale/group business often feel that they are losing control over their inventory as a RM system may not make inventory available for high season periods. Harrah's lost a quarter of their casino hosts when they converted to this RM system chainwide. In addition, hotels or casinos that used to locally set rates often need to review the recommendations from a centralized RM department, thus decreasing a hotel's sense of autonomy. These changes can be threatening to employees.

RM system implementation typically requires changes to existing business processes. The typical areas include reservation or booking processes, wholesale or group rate quotations, casino blocks, casino marketing and promotions, and events. Harrah's mitigated the challenge of business process change by attending Rainmaker's Revenue Management Best Practices (RMBP) workshop. Rainmaker asks key representatives of every area that will be touched by the RM system to attend a workshop. Most attendees will rarely, if ever, have direct interaction with the system, but they will feel the impact of the RM decisions. RMBP workshops themselves are tailored to the specific client and grow out of Rainmaker consultants' observations and interviews with staff across the organization, to learn how RM activities were conducted independently of an automated RM system. Those practices are compared and contrasted with industry best practices; workshops highlight practices that are consistent, and those that deviate from best practices. The consultants draft "case study" exercises for participants to work through in groups. The case studies are based on Rainmaker consultants' previous experience in the gaming industry and stress the particularly important points of the RM system. In addition, the workshops feature a full system demonstration so that everyone will have a chance to see what kinds of information the system contains, how it produces its recommendations, and so forth. Not surprisingly, the more widespread (and less mysterious) the knowledge of RM processes can be made; the more readily the associated changes are accepted. More information on the human side of RM can be found in Skugge (2004) and Queenan et al. (2007).

Summary

The Cherokee generates high returns by applying RM to its business. The Cherokee generates these returns partly because of the nature of the gambling industry and partly because of the tight integration between their CRM and RM systems.

The gaming industry naturally has a wide range of willingness-to-pay (or gamble) among its customers. Casinos regularly see customers willing to lose $50 and others ready to lose $2000. This contrasts starkly with other RM applications, such as airlines or hotels, where the price differentials generated through RM are much smaller. This is the classic problem in RM, and when the differential is so large, every RM improvement returns more profit. Researchers expect casinos to earn large payoffs from RM systems because of this differentiator. But, the Cherokee further enhances its systems through tight integration of marketing and RM.

Because of the Cherokee's CRM system, the Cherokee knows exactly how much each customer plays. This allows the Cherokee to exactly segment customers by willingness-to-pay instead of creating fences as airlines and other industries do.

The Cherokee is able to forecast demand well. Since the majority of their customers book their rooms very close to the day when they plan to stay there, very few customers cancel or no-show, which enhances ability to forecast. The Cherokee's forecasting ability is also enhanced through capturing demand that is turned down by recording customers' reward card number before customers request a room. This increased forecasting accuracy leads to more optimal decisions and higher profitability.

Because of their accurate forecasting, the revenue manager at the Cherokee knows when hotel occupancy could be low. She tells marketing and marketing

selectively targets customers (identified by the CRM system) to encourage a trip to the casino on the underbooked days. Marketing personnel carefully track these efforts to increasingly refine their efforts for optimum payoff.

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Exhibit 1: A Typical Revenue Management Process

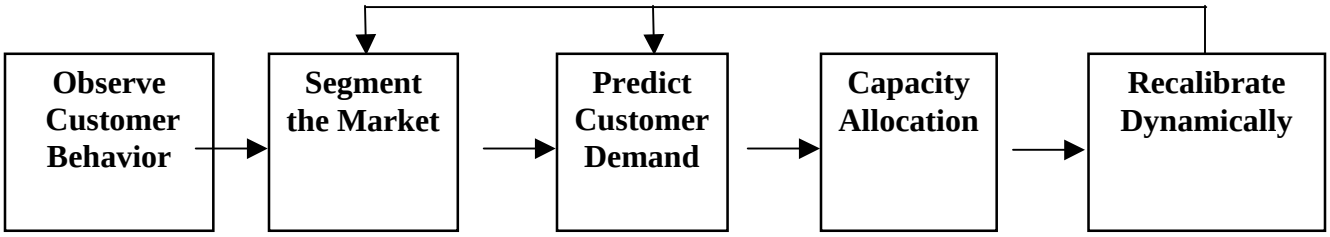


Exhibit 2: Flowchart of RM decision process at the Cherokee

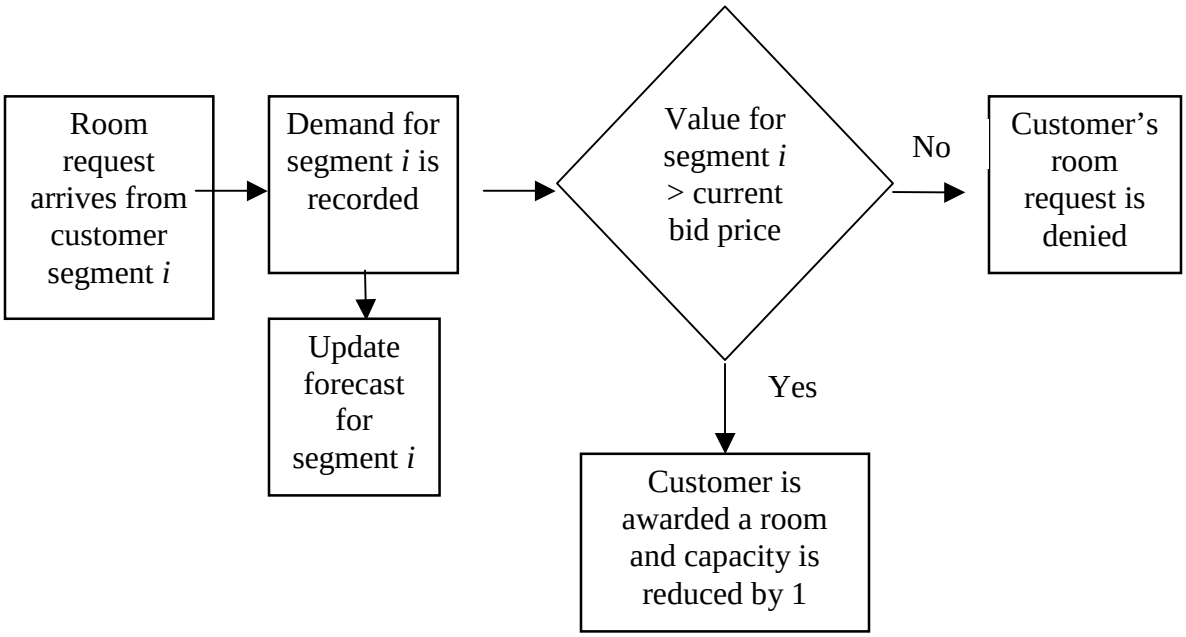


Table 1: Cherokee Customer Segmentation Scheme (Approximate Data):

Thursday Data for a Friday Event

Segment	Expected Wagering Profit	Uncon-strained Demand	Demand Override	Rooms Allocated	Current Sold	Bid Price
CS0	≥1,000	119	119	120	84	RFB1*
CS1	800-999	128	128	122	75	RFB2*
CS2	600-799	126	126	124	69	ROC*
CS3	400-599	122	**150**	138	79	ROC*
CS4	300-399	155	155	43	43	$125
CS5	200-299	168	168	0	0	$225
CS6	100-199	144	144	0	0	$325
CS7	50- 99	103	103	0	0	$375
CS8	0- 50	92	92	0	0	$425
CS9	unknown	45	45	0	0	$450

*RFB1 refers to "Complimentary room, food, and beverage at level 1, the best rooms and restaurants available. RFB2 refers to a lesser level of complimentary meals. ROC indicates the "room only" is complimentary.

Table 2: Possible Revenue Streams: Representative Weekend Night

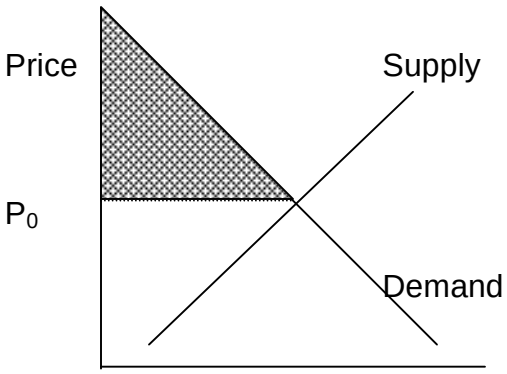
Segment	Expected Wagering Profit	Rooms Sold: RM System	Gross Revenue: RM System*	Rooms Sold: Optimal	Gross Revenue: Optimal*	Rooms Sold: No System	Gross Revenue: No System**
CS0	≥1,000	120	$180,000	125	$187,500	55	$89,375
CS1	800-999	122	$109,800	130	$117,000	55	$56,375
CS2	600-799	124	$86,800	124	$86,800	55	$45,375
CS3	400-599	138	$69,000	140	$70,000	55	$34,375
CS4	300-399	43	$15,050	28	$9,800	55	$26,125
CS5	200-299	0	0	0	0	55	$20,625
CS6	100-199	0	0	0	0	55	$15.125
CS7	50- 99	0	0	0	0	54	$10,800
CS8	0- 50	0	0	0	0	54	$8,100
CS9	unknown	0	0	0	0	54	$12,150
Total		547	$460,650	547	$471,100	547	$318,425

* Gross Revenue calculation assumes $1,5000/night for CS0 segment, and the midpoint of the Expected Wagering Profit for other segments.

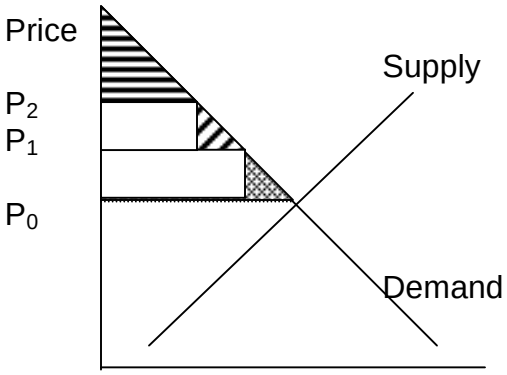
** Gross Revenue also assumes no complimentary rooms, a room rate of $125/night and $100 gaming revenue for segment CS9 (unknown customers).

Figure 1: Traditional Revenue Management Pricing

Pricing Without Revenue Management



Pricing With Revenue Management



Pricing of Gambling at Casinos

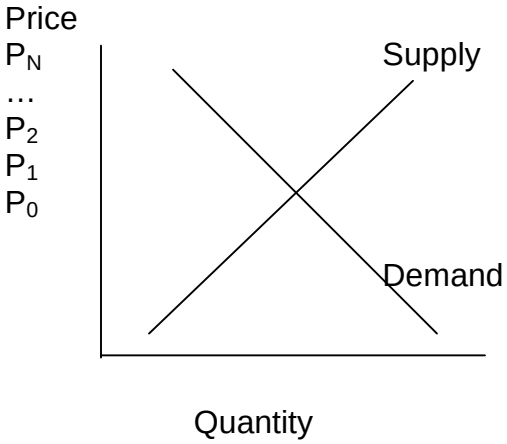


Figure 3: Booking Curve of a Typical Weekend

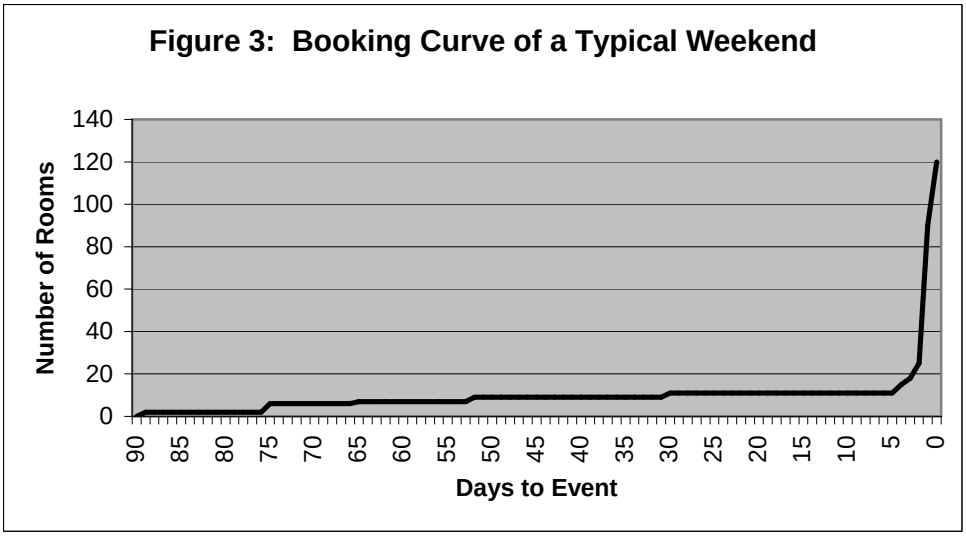


Figure 2: Screen Shot of Customer Segmentation

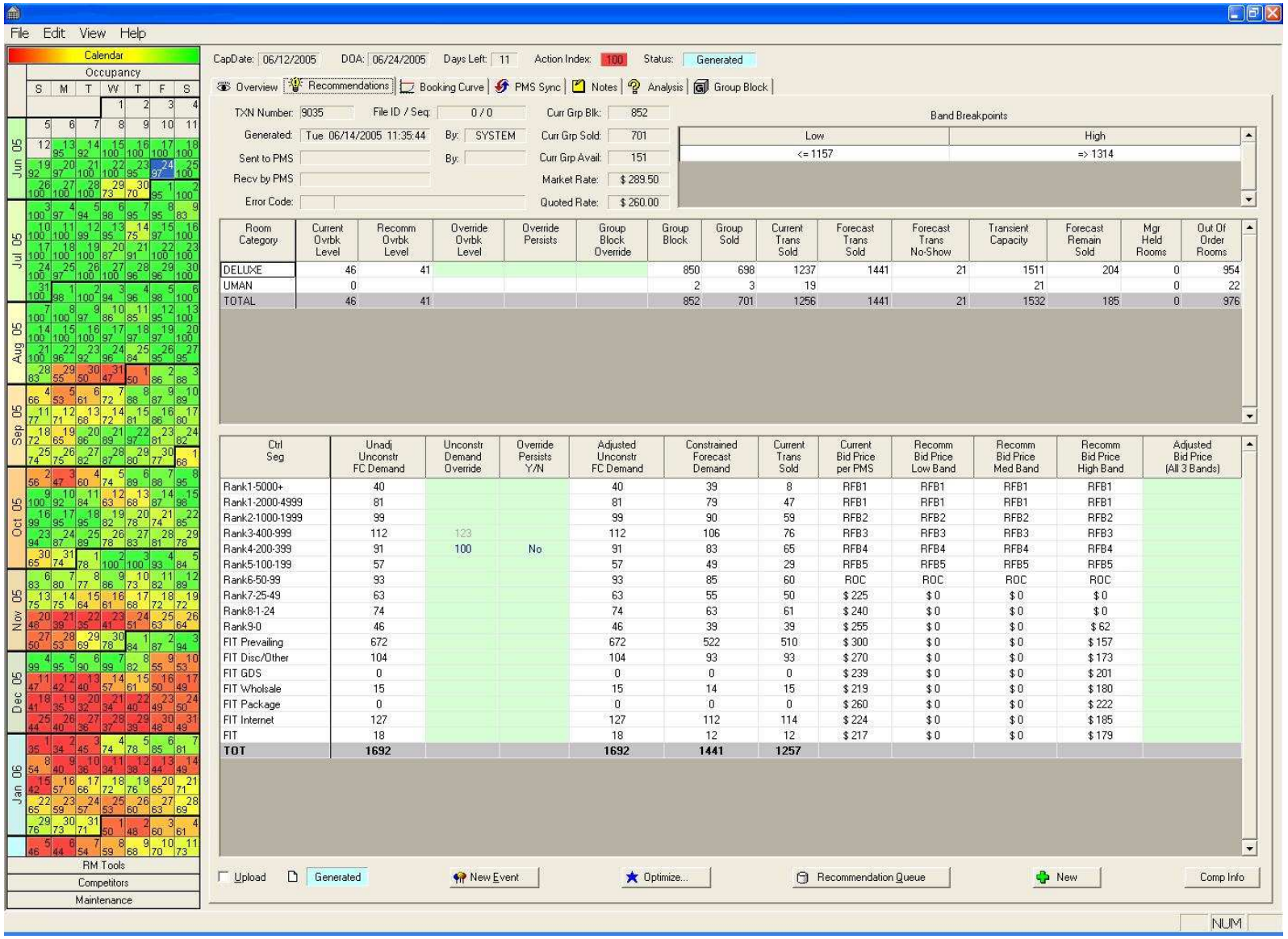


Figure 4: Screen Shot of Booking Curves