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 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 table games. We investigate what drives this phenomenal success.

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, Mr. Smith's reservation attempt contains several strikingly 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. Through detailed customer relationship management and sophisticated revenue management, Cherokee employees know that these are smart decisions, contributing to the profitability of the hotel.

In other industries, revenue management systems have increased revenue 3-7% (Cross 1997). The revenue management 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 revenue management 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% margin on gross revenue.

Revenue management applications in the gaming industry have received minimal attention in 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 revenue management system, describing innovative revenue management algorithms is not the purpose of this work. Rather, our goal is to showcase the success and value of the most extreme application of revenue management. Indeed, the Cherokee represents the "killer ap" of revenue management.

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 contracted to start the hotel, with Harrah's sharing incrementally 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 community. The Cherokee divides casino profits into several tribal community funds, supporting better healthcare, education, and other initiatives to increase the tribal standard of living. The

"per capita" fund pays each enrolled tribal member bi-annually. In 2005, the per capita fund paid over $4,000 to each member. 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. However, the Cherokee recognizes that their customers can easily get on a plane and go to Vegas, or any other gambling location, and their customers can play table games and drink at these other locations. Because of some of these handicaps, the Cherokee knows they must excel in other areas and therefore prides themselves on personal, friendly service which their customers value.

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 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 features 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 nor 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. Let's take a look behind the curtain to see how the magic is performed.

Revenue Management in Casino Hotels

Revenue management for casino hotels makes for different decisions than occur at typical hotels. Returning to our opening example of Joe Smith calling for a room reservation, we will explain why the reservation agent offered to book Joe a room at a neighboring hotel. This occurs because the revenue management system predicts that 183 rooms, roughly one-third of total capacity, should be kept available for customers that gamble more than Mr. Smith, and who is expected to request a reservation within the next 24 hours.

Further, Mr. Smith received a free room. This is 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 most want to increase 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. Academics have been advocating incorporating ancillary spend in revenue management applications (Noone and Griffin, 1997; Noone et al., 2003), but implementation has been slow. We will show why incorporating total spend in casino applications is crucial.

Cherokee's product offering is gambling, and all other products (such hotels, restaurants, and entertainment facilities) support the gaming experience. As a result, the pricing aspect of gaming industry revenue management turns the traditional model on its head: Instead of the desirable customers being charged more, they are charged nothing. Beyond not being charged for a room, the "pricing" decision to be made is how many other free services and goods should be given to different levels of customers.

It's only the least desirable customers that generate room revenue. The goal of the Cherokee is to have a full hotel with an average room rate of $0/night – that would mean the hotel is full of active players.

The principles of casino revenue management are similar to those in other industries, but decisions have larger impact. This difference is due to the huge differential in willingness to pay between the highest and lowest customer. In an airline application, the premium paying customers may pay 3-5 times more than the discount seeking customers. The best customers in the gaming industry will pay 20 to 50 times what the lower revenue customers will pay. For example, there are customers willing to lose up to $50 dollars per day, but there are also customers willing to lose several thousand dollars per day. This huge differential in customer willingness to pay makes it essential for casinos to ensure that their highest gamblers always have a place to stay, even if that means turning away lower paying gamblers.

Customer Tracking

Most revenue management systems require substantial guesswork as to how much a customer is willing to pay, and requires imaginative uses of rules to force customers to pay a higher price. For example, airlines charge higher rates if one does not wish to stay over a Saturday night, in an attempt to segregate business travelers from leisure travelers. Airlines presume business travelers are willing to pay more and do not wish to stay over on Saturday night. Therefore, airlines use the Saturday night rule as a proxy for business travelers. However, this is a porous segmentation as business travelers can choose to stay over on Saturday and leisure travelers can

choose to not stay over.   Ideally, airlines want to charge the business customer what they are willing to pay, but few travelers will freely admit what they will pay and instead always choose the lowest price. Because of this, airlines and other businesses must use artificial rules like Saturday stay-overs to implement their desires.

Firms using revenue management accept these challenges as they are endemic to the process. But these imperfections are minimized at Harrah's, which uses its customer relationship management (CRM) system to increase the value of its revenue management system.

Harrah's CRM system is based on the "Total Rewards" card program, which tracks customer's wagers. Before playing an electronic game, customers enter their card in the gambling device, and the card tracks their play electronically. For table games, the customers present the card to casino employees, who note the average wager and duration of play. The Cherokee give complimentary or reduced price rooms, meals, casino chips, free valet service and other perks and amenities to those who have more tracked play. Hence, customers have strong incentives to use their Total Rewards card. At the Cherokee, over 80% of the money wagered is "tracked" play.

On the micro level, this CRM system allows the Cherokee to know, on average, how much a customer will spend on a given visit. Customers who spend more per visit are given higher priority, and their gambling losses are essentially how much they pay for a room, even though technically the room may be free. On average, guests at the Cherokee "pay" $565/night.

The Cherokee has far fewer rooms than potential customers. 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 incentives, customers gladly use their reward cards everywhere in the casino. Due to the customers' happy compliance, the casino knows how people gamble, and can track how marketing initiatives affect that gambling pattern, and improve each initiative.

On a macro level, the Cherokee can track individual machine total customer spend per hour and casino total customer spend. From this data, the Cherokee rearranges the casino to optimize traffic flow, and decides how to time prize drawings to encourage guests to stay a little bit longer (and spend more). The Cherokee tightly integrates marketing and revenue management functions so that CRM and RM data enhances and supports each other for continued profitability increases. 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 customers who may want to stay at the Cherokee. Then, marketing sends automated phone calls, e-mail blasts, or outgoing live calls to the targeted customers. These communications promise additional incentives to come to the casino on the specific dates needed.

This tracking differs significantly from traditional casino practice. Casino staff have always known and pampered their big spenders. However, a knowledgeable employee tracked the customer on a personal level, and the tracking was done on a more informal basis so that actual customer spend was not really known. Further, the

designation of a customer suited for special treatment could also 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. 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 revenue management system.

Revenue Management System

While day-to-day booking decisions are made by hotel staff, the back-office aspects of the revenue management system at Cherokee are managed by Rainmaker. Rainmaker manages revenue management systems for many gaming industry properties. The system was initially developed by Manugistics (formerly known as Talus, and before that, DFI-Aeronomics). Manugistics has developed revenue management solutions for National Car Rental (Geraghty and Johnson 1997), Hertz (Grimes and Carroll 1995), Ford, Hilton, Marriott, TUI, Omni Hotels, Continental Airlines, Sommerfield, and Limited Brands among other firms.

As is typical in revenue management situations for hotels, the system does not handle all rooms or customers. Casino hosts directly book the extremely high value, VIP customers. The revenue management system forecasts demand for 547 of the 576 rooms in the hotel. Casino hosts schedule all suites and use a more detailed form of analysis to determine the right guest for the right suite.

The system forecasts demand for guests by booking date, arrival date, length of stay, room type, and customer segment. These forecasts are then fed into overbooking and optimization models which recommend inventory controls. The optimization model is a special case of the price-inventory management model presented in Kuyumcu and Popescu (2006) and produces optimal bid prices and the amount of demand to accept from each customer segment.

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 they are giving 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. Exhibit 1 shows the customer segmentation scheme. Ten customer segments are delineated based on expected gaming losses or historical "coin-in" – the amount of money wagered. The number of guests from each segment staying at the hotel on an average night is also depicted.

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 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. Exhibit 1 depicts a night when the Cherokee closed bookings to CS5 and below, and limited CS4 to 41 rooms. This level of closure is not

unusual. For many weekend nights in the summer of 2006, the Cherokee closed reservations at level CS0 (>1,000), and excluded customers with a theoretical profit of $0-$1,000.

Like nearly all revenue management segmentation schemes, the customer does not see this segmentation. Typically, a business must hide its segmentation scheme from customers to avoid customers taking 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 the same room can be had for a lower price for a different customer segment, 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 the gaming industry and revenue management is that the customers motives are in synch with the segmentation scheme, rather than trying to subvert it. The customer does see a segmentation scheme at Harrah's, just not the precise one in Exhibit 1. The Total Rewards cards have three different levels, rather than ten. Each successively higher level is associated with larger perks and discounts, and levels are attained by the amount of customer gambling.

Booking Curve

The booking curve differs for the Cherokee versus other businesses that utilize revenue management 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

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discounted international flight seats a year in advance, and these seats frequently sell out within days. Discounted hotel rooms associated with conferences are often blocked out years in advance. Often customers book full coach airfares and rack rate hotel rooms only a week or two in advance.

The Cherokee differs. Figure 1 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.

This sharp spike in the booking curve speaks to an intense need for a revenue management 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 revenue management between the Cherokee and typical hotels is that there's no major difference in the shape of the demand curves between customer segments. All the customer segments tend to wait until the day of the event to make a reservation.

Demand Forecasting

As noted earlier, the occupancy of the hotel is 98.6%. Typically, an occupancy rate this high is indicative of poor revenue management. The traditional way to get high occupancy is to accept all reservations as they come in, which leaves the desirable customers shut out when they book later. Best practice revenue management 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 room remain unused. Indeed, Rainmaker reports that in a typical gaming application, occupancy will go down four percent – though revenue will go up 17%. The Cherokee avoids this fate for three reasons: The first is highly accurate forecasting, the second is the nature of their last-minute business, and the third is the low no-show rate.

Forecast accuracy is greatly improved because of the Total Rewards system, which helps to identify the unconstrained demand In other revenue management applications, having a history of reservation denials by customer segment is either impossible or not done. Consequently, most firms have only censored data to determine the true demand for their services. However, Harrah's is able to track reservation denials by customer segment since customers divulge their Total Rewards number prior to requesting a reservation.

The nature of the last-minute reservations also helps to create a high occupancy rate that does not detract from profitability. Typically for airlines and hotels, the discount business books well in advance, and is prohibited from booking at the last minute. That's how these businesses are able to segment their customer base. Unfortunately,

that leaves these businesses with empty seats and rooms if the high paying customers do not show up as forecast. For the Cherokee, however, this is not the case. If it's 8pm on a Friday night, and the high-rollers just aren't showing up as forecast, the low-rollers are still there, asking for rooms and can be let in.

The no-show rate and resulting overbooking are essential elements of any revenue management system concerning hotels. However, the no-show rate at the Cherokee is quite small and predictable, averaging only 7 per night Monday-Thursday, and 15 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 plan changes.

The overall forecasting process starts by an unconstraining method that utilizes denial and regret data. The seasonality is calculated using a two-stage Fourier model. An enhanced Kalman filtering is utilized to estimate the steady-state and variance values of all key business statistics. The forecasting components include current bookings, expected unconstrained arrivals, seasonality, trend, booking curve and length of stay fractions, event factors, and user-overrides. The final forecast is generated by booking date, arrival date, length of stay, room type, and customer segment and fed into the overbooking and optimization processes.

Implementation Difficulties and Challenges

When a new pricing or revenue management practice is introduced, there may be initial resistance and lack of trust to the system-generated recommendations. This was also the case at Cherokee implementation.

The implementation challenges and ongoing usage of the RM can be broadly categorized into three categories:

- People

- Business processes

- Data quality and timeliness

The RM system impacts day-to-day activities of many people; some of them embrace the change and others resist to it. For example, casino hosts and personnel that book wholesale/group business often feel that they are losing control over their inventory as RM system may not make inventory available for high season periods. In addition, hotels or casinos that used to locally set rates now need to review the recommendations from the centralized RM department. At Cherokee, executive-level support, dedicated staff, and proper training programs were keys to overcome these challenges.

RM system implementation typically requires minor or major 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. In addition, some revenue managers excessively override either system forecasts or recommended rates to make rates particularly more aligned with what they believe is the "right price". Cherokee RM managers are required to attend the Rainmaker RM Best Practices workshop which instills RM discipline and presents changes to the existing business processes to achieve the RM goals. In addition, the

RM system monitors and reports the frequency, severity and applicability of the user overrides.

Finally, the RM system is a data-driven system and its results highly depend on the timely feed of the quality data. The RM system requires collecting and integrating the data across multiple applications including, but not limited to Property Management System (PMS), Casino Management System (CMS), and Customer Relationship Management System (CRM). Although Harrah's made a lot of progress in integrating these applications, collecting better data (particularly lost business) and improving the data quality remains a top priority.

Summary

The Cherokee generates high returns from applying revenue management to its business. They generate these returns partly because of the nature of the gambling industry and partly because of excellent execution.

The gaming industry naturally has a wide range of willingness to pay (or gamble) among its customers. Casinos regularly see customers willing to gamble $50 and others ready to gamble $2000. This willingness to gamble (or lose) $50 versus $2000 dollars correlates to a willingness to pay for the gambling experience, and calculates to a 20x willingness to pay for the highest versus lowest customer. This contrasts starkly with airlines, where firms struggle to charge one customer $2000 versus another $50 for fear of losing the $2000 customer on future flights. For this reason, airlines (and other industries) must keep the product price range fairly small. The 20x willingness to pay in the casino industry makes it ever more important to keep a room open for a late arrival

because of the huge profit at stake. This is the classic problem in revenue management, and when the differential is so large, every revenue management improvement returns more profit.

Researchers expect casinos to earn large payoffs from revenue management systems because of this differentiator. But, the Cherokee further enhances its systems through tight integration of marketing and revenue management, and their constant vigilance operationally.

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 having to set up proxy fences as airlines and other industries do. Customers of the Cherokee book rooms very close to when they plan to stay there. Because of this short term planning horizon, there is a low amount of no-shows, which enhances forecasting ability. Increased forecasting accuracy leads to more optimal decisions and higher profitability.

Because of their accurate forecasting, the revenue manager 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.

Due to the nature of *Interfaces* this article has focused on the various systems that have aided the Cherokee. However, it should be stressed that merely turning on these systems does not yield profits. The excellent execution of the Cherokee's staff

along with the prime application of revenue management in a casino lead to this killer ap.

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Exhibit 1: Average Cherokee Customer Segmentation Scheme (Approximate Data)

Segment	Expected Wagering Profit	Number Of Rooms
CSO	≥1,000	120
CS1	800-999	122
CS2	600-799	124
CS3	400-599	138
CS4	300-399	43
CS5	200-299	0
CS6	100-199	0
CS7	50- 99	0
CS8	0- 50	0
CS9	unknown	0

Figure 1: Booking Curve of a Typical Weekend