Service Engineering: The Future of Service Feature Design and Pricing

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1 Introduction

U.S. airlines achieved a startling turnaround in 2009. Profits rose to $2.3 billion after a loss of $3.3 billion the year before. Also during 2009, the airlines collected $2.7 billion in baggage fees (U.S. Bureau of Transportation Statistics 2010). In other words, by charging separately for a service once associated with the price of a ticket, the airlines turned a potential loss into a profit. Unbundling baggage handling from ticket prices also served consumers. By ensuring the industry's financial health, it allowed airlines to offer a wider selection of flights. It also helped carriers keep ticket prices low, directly benefiting those who chose to take carry-on luggage instead of checking their bags.

Unbundling is an example of the rapidly emerging field of service engineering. Service engineering involves designing and pricing derivative services to appeal to broader markets and to improve resource utilization. Other examples include:

- Companies that offer discounts to customers who book a ticket, hotel room, and car at the same time;
- Tour operators that substitute similar hotels based on their price and availability;
- Providers that offer discounts conditional on their right to recall the service or offer an alternate service;
- Rental companies that sell excess cars on name-your-own-price (bidding) Web sites; and
- Staffing agencies that offer options to provide a given number of programmers for large projects.

The resemblance between the terms "service engineering" and "financial engineering" (and use of the word "derivative") are not accidental. Service engineering strives to create equivalents of such financial derivatives as options, puts, calls, bundling, and unbundling to modify a core service.

Like financial engineering, service engineering is a strategic tool that helps service providers build portfolios of offerings in ways that manage risk, improve resource utilization, and boost revenues. Service providers can use its set of tools to design and price derivative services to segment the market in order to offer premium products and also reach customers that otherwise would not be interested in the company's offer. Customers benefit from a wider range of services and price points, enabling them to tailor their purchases to their budget. This makes service engineering a strategic tool that can lead to significant increases in profits and market share.

So what, exactly, is service engineering? In essence, it involves the virtual or operational modification of an underlying service. Virtual modifications are real (non-financial) options that affect the fulfillment or consumption of a service. Service providers can use them to mitigate supply or demand risk. For example, a company may obtain fulfillment options from customers that allow it to substitute one room for another or place a customer on one of several flights. It can then sell this flexibility in the form of consumption options to customers willing to pay a higher price for the right to decide which room or flight they want at the last minute. Real options can also be used to sell recurrent services to customers with heterogeneous usage rates, and form the basis for contracts with access fees and limited usage allowances.

Operational modifications involve adding (bundling) or removing (unbundling) ancillary services from core services. This creates varied versions of the service that appeal to different market segments. Bundling involves selling two or more services in packages that appeal to a range of market segments that value these service combinations differently. Unbundling consists of separating service features and charging separate prices for each. Both approaches can be used in versioning, offering a line of services distinguished from one another by their combination of features as well as usage or purchasing restrictions that differentiate their quality.

In addition to helping manage resources and risk, customer segmentation using derivative products enables service providers to reap many of the advantages of secondary markets. Sellers can usually limit the resale of services in secondary markets, since unlike physical products, services cannot be stored and must be used by a certain date and time. A particular case are "experience goods" (Nelson, 1970), which include healthcare, travel, entertainment, and performing arts. These products are highly intangible and cannot usually be experienced or tested before purchase. This limits opportunities for temporal arbitrage and secondary market resale of these products, although a flourishing secondary market for event tickets has emerged in spite of preventive efforts of primary providers and lawmakers (Happel and Jennings, 1990).

From a marketing perspective, service engineering is analogous to the problem of developing the rules of a transaction game (Shugan, 2005). By attempting to match most efficiently the needs and preferences of all partners in the transaction (buyers and sellers), the design of services determines both the likelihood of desirable outcomes and whether players will choose to play.

This chapter addresses these issues in depth. In Section 2, we discuss virtual service modifications, a variety of real options that improve profits by segmenting customers. These include fulfillment options, consumption options, and real options for access services.

In Section 3, we investigate operational service modifications. These include bundling, unbundling, and versioning. We also introduce concepts from financial engineering to illuminate the problem of designing and pricing bundles.

In Section 4, we discuss ways to apply service engineering to revenue management and customer relationship management. We discuss our conclusions in Section 5.

2 Real Options

Service engineering strategies based on real options can be classified in three broad categories. These consist of fulfillment options for the seller, consumption options for the buyer, and options used for accessing services. In this section we discuss these three categories, providing definitions and actual or potential applications.

2.1 Fulfillment options

Fulfillment options reflect seller rights to use different fulfillment alternatives. Some examples are upgrading, upselling and bumping customers. Fulfillment options are designed to broker flexibility between flexible buyers with low willingness-to-pay and inflexible buyers with high willingness-to-pay. Fulfillment options reduce imbalances between demand and capacity, so they are particularly useful when capacity is limited and customers have heterogeneous consumption flexibility. The use of options may result in demand induction as customers who would otherwise not have considered buying the product respond to incentives. This can be helpful for companies even when capacity is ample. The use of options, however, may also result in demand cannibalization if customers form expectations about the likelihood of different fulfillment alternatives. Consequently, the design of fulfillment options must carefully trade-off the benefits with the potential downside.

2.1.1 Callable services

Callable products have been proposed by Gallego, Kou and Phillips (2008) as a strategy for a company to maximize revenue from selling constrained capacity to customers with large heterogeneity in their willingness to pay. This is particularly relevant when selling in a market where customers with higher reservation prices arrive later than customers with lower reservation prices, as is the case in the leisure, entertainment, and travel industries. The concept is also useful in supply chain settings where there are customers that are willing to pay a significant premium for shorter order fulfillment lead times. Customer heterogeneity in willingness to pay for different fulfillment leadtimes gives raise to advance demand information, which helps the producer better plan for its inventory and distribution system; see Fisher (1997), Chen (2001), Gallego and Özer (2001), Özer (2003) and references therein.

A callable service embeds an option for the provider to recall the capacity at a pre-specified price before the service is delivered. Callable services are either sold at a discount or with an enticing recall price premium in order to compensate the customer for the potential inconvenience of having the service recalled; they can also be sold without a discount and with a small recall price when demand greatly exceeds supply. Callable services are appealing to customers with relatively low service valuations, or those with flexible consumption timing. For example, a cruise line could sell discounted callable cabins to flexible, price sensitive, customers and later recall them if and when full rate demand exceeds available capacity. For this to work, the recall price needs to be, of course, lower than the full rate. A customer whose service is recalled may be offered an alternative service and a compensation. In the context of supply chain management, callable services may be sold to customers with predictable demands who operate with low margins. The predictability of their demands allows them to opt for lower prices and long lead times, while their low margins make a modest recall premium attractive. The flexibility gained by selling callable services can be used to accommodate the needs of customers with unpredictable demands who operate with high margins, as those customers are usually willing to pay a significant premium for shorter delivery lead times.

Callable services can also be an effective tool to prevent or mitigate the formation of secondary markets. In the entertainment industry, for example, primary providers of premium events often run out of capacity early on, with tickets later selling at much higher prices in the secondary market. By selling callable services when tickets first become available for sale, primary providers can discourage arbitrageurs from loading themselves with capacity that may later be recalled. In addition, selling callable services allows the primary provider to participate in the secondary by recalling previously sold capacity as needed.

Gallego et al. (2008) show that, under mild conditions, callable products are a riskless source of additional revenue to the capacity provider and can be a win-win strategy to the provider and to both low and high valuation customers. They also show that callable products may induce demand from customers who may find the recall price just attractive enough to purchase a product that otherwise they would have not purchased. The concept of callable services is related to the strategy of *contingent pricing* (Biyalogorsky and Gerstner, 2004), arising in transactions where the price is contingent on whether the seller succeeds in obtaining a higher price for the service during the period between sale and fulfillment. They show that contingent pricing increases the efficiency of resource allocation since the service is eventually sold to the customers with the highest reservation price.

2.1.2 Flexible services

A flexible service is a virtual offer involving the guarantee of receiving one out of a set of several alternative services, typically substitutes (Gallego and Phillips, 2004). The seller decides the exact assignment close to or at the time of fulfillment on the basis of demand information acquired during the selling process. Flexible services are often, but not necessarily, sold at a discount in order to compensate the customer for the uncertainty of the final service assignment. For example, a customer may advance purchase a flexible airline ticket that guarantees air transportation between London and New York on a certain date in one of the three morning scheduled flights. The day before the travel, the airline assigns the customer to one of these flights based on the realized demand. Since the airline is free to assign passengers that have purchased the flexible service to any of the three morning flights, the airline can do better at accepting higher fare requests for these flights. Although flexible services are similar to callable services, they expose customers to different forms of uncertainty. While the flexible product guarantees fulfillment within a set of pre-specified alternatives, buyers of callable services are not guaranteed the delivery of the service. Flexible products are also closed to opaque services discussed later in this Chapter.

Flexible services can also be sold without an upfront discount when customers have a preference for a specific choice, with compensation occurring only if the customer is fulfilled with an alternative. The concept of flexible services can be pushed further to encompass conditional upgrades in the form of free put options on higher quality services. For example, at the time of purchase, a customer who selects a $100 standard room over a $150 deluxe room with an ocean view, may be enticed to agree to pay an extra $15 per night for the deluxe room if he is given an upgrade at the time of check-in. This is a flexible service sold at $100 per night, where the alternatives are the standard room and the deluxe room with the customer agreeing to pay $15 per night if he is upgraded. If the customer agrees, then the provider has the right but not the obligation to sell the deluxe room for $115 per night.

Flexible services are commonly used in industries such as Internet advertising, tour operators, and air cargo. They are also used in electricity markets where customers may agree to have a device that can remotely and intermittently shut down their air conditioners in exchange for a discount on their monthly fees. The concept of flexible services has parallel implications in supply chain management. In this setting some customers will be willing to accept a larger variance in lead times in exchange for a lower price, and this may allow the provider to offer more predictable lead times to customers willing to pay for it.

Although the main purpose of selling flexible and callable services is to improve capacity utilization by reducing the imbalance between capacity and demand, they also have the potential benefit of inducing new demand for the provider's services. When the price for the flexible or callable service is sufficiently low, it may attract customers who otherwise would not be interested in any of the provider's services at their full price. On the other hand, flexible and callable services may cannibalize demand from customers who would have otherwise advance purchased one of the specific alternatives. The key here is to carefully limit the number of services sold in order to avoid buying more flexibility than is needed.

The pricing of flexible services is an interesting research topic. Post (2010) proposes offering a large set of alternative services and then charging customers to reduce the consideration set. Customers are allowed to eliminate all but three alternatives and are guaranteed to receive one of the non-eliminated alternatives. As customers pay to eliminate undesirable alternatives, they are essentially paying to reduce consumption risk. When the price is right, the revenues from eliminated alternatives can be a significant source of profit for the provider. Some airlines have implemented the pricing strategy suggested by Post's company Sigma-Zen. Germanwings, for example, proposes blind bookings that typically consist of eight or more destinations within a certain theme such as "culture" or "sun and beach" at deeply discounted prices (typically 20 euros), giving potential customers the ability to remove from the choice set all but three destinations at a cost of 5 euros for each removed destination.

Flexible services are related to *probabilistic goods* which are offers involving the probability of obtaining any one of a set of multiple distinct services. Fay and Xie (2008) show that, by introducing buyer uncertainty in the service assignment, a probabilistic selling strategy may increase capacity utilization through reducing the imbalance between capacity and demand. Unlike selling flexible services, however, in probabilistic selling the service assignment is confirmed immediately after the purchase, and before the seller has acquired any new information about demand.

2.1.3 Upgrades and upsells

Upgradeable services are an alternative mechanism for reducing capacity and demand imbalance and improving capacity utilization (Biyalogorsky et al., 2005). They are relevant for capacity providers who offer several services differentiated by their quality attributes. The seller of an upgradeable service has the option of replacing it at the time of fulfillment with a more desirable substitute from a pre-specified set of alternatives. Gallego and Stefanescu (2007) study different upgrade mechanisms and show that, as implicit price reductions, upgrades and upsells help balance demand and supply by shifting excess capacity from higher to lower quality services. Upgrades are frequent in package delivery and other transportation activities that offer priority options at differentiated prices, and in the semiconductor manufacturing industry where fast chips are sometimes used to fulfill demand for slower chips. They are also common in leisure, travel and entertainment industries, where the more desirable alternative could be a larger hotel room, a higher flight cabin class, or a better concert or theater seat. Upgrades can also be used by other providers of services such as web-farms that offer different service qualities with promised up-times. Customers who opt out from paying a premium for gold service may still receive a high level of service except for peak demand periods.

Besides offering free upgrades, companies sometimes entice customers to buy up to a more desirable service by offering attractively priced substitutes at the time of fulfillment. This upsell practice is common for car rental companies, hotels and airlines. When the customer agrees to an upsell, he pays less than the full price for the more desirable service, but more than the price of the less-desirable service initially chosen.

While upgrades are frequently practiced by primary providers of capacity, resellers often also have an additional incentive to use upgrades extensively. The resellers' profit margins on different services are usually heterogeneous; in particular, resellers may sell both their own services and inventory on commission from primary providers. In these situations the resellers have an incentive to fulfill demands with desirable substitutes bringing higher commissions, thus effectively offering an upgrade. This often happens in online brokering of perishable capacity, such as in the secondary market of event tickets, and to a lesser extent with online travel agents that carry large inventories. The practice is also pervasive in standard retail environments where customers are steered to higher margin products through coupons or recommendations.

Gallego and Stefanescu (2007) show that access to commission services can significantly improve the reseller's profits even though direct sales of such services only account for a small profit increase. This is due to the fact that resellers can divert demand from the primary provider's services to their own services with higher margins, by enticing customers to upgrade or upsell. However, an excessive use of upgrades may result in low net sales of services belonging to primary providers, damaging their long term relationship with the reseller. This can be avoided by imposing lower bound constraints on the number of sales fulfilled with any given service sold on commission from the primary capacity provider.

The efficient design of upgrade and upsell mechanisms provides a rich topic of future research. One issue to be investigated is the definition of the alternative service sets for each upgradeable service, so that certain fairness criteria are met. Another issue is the optimal timing of upgrades and upsells over the selling horizon; companies have an incentive to delay upgrade decisions until more demand information has been acquired closer to fulfillment time, but doing so motivates customers to delay purchases and thus increases demand uncertainty. More research is also needed on the link between the timing and design of upgrades and the customers expectation formations, as frequently-upgraded services may become more attractive and induce customers to deliberately purchase lower quality services, further increasing the imbalance between demand and supply.

A related research topic of a more strategic nature is optimal capacity design that anticipates the use of upgrades. If the capacity provider knows that a higher quality service can be used to fulfill demand for an inferior service, he may decide to increase the capacity of the higher quality service at the expense of the lower quality service. This is particularly true if the difference in cost is small. As an example, car rental companies routinely buy more full size than compact cars. Capacity providers need to balance this additional flexibility against the extra cost and potential for customer expectation formation, when deciding the optimal capital allocation between different service quality levels.

2.1.4 Bumping customers

Bumping customers from a previously purchased service involves assigning them at consumption time a service of lower value than that originally purchased. The probability of bumping is not explicitly priced into the service cost and sometimes customers are bumped against their will, therefore bumping is strictly a fulfillment option on the part of the capacity provider, rather than a service design feature.

Bumping is often a consequence of *overbooking* (taking more bookings than available capacity), a strategy frequently used by hotels, airlines, and other service providers as a way of hedging against cancellations and no-shows. Airlines, for instance, bump travelers by finding volunteers to give up their seats in exchange for cash and/or loyalty points and alternative accommodation. Bumping also occurs in supply chains when product manufacturing or transportation is purposely delayed in order to accommodate emergency orders for higher margin products or customers. Such delays cause production and distribution disruptions downstream that can be mitigated by selling callable or flexible products.

When the bumping costs to the provider are smaller than the difference between the lowest and the highest price, the company may continue selling high price services after demand has exceeded capacity, since it is feasible to free capacity by bumping low price customers without hurting revenues. However, when customers are involuntarily denied there are also indirect costs in terms of ill-will. Airlines try to avoid ill-will by holding auctions to identify volunteers willing to take a different flight in exchange for suitable compensation, e.g., coupons for future flights. Phillips (2005, page 208-209). However, bumping costs have increased in some industries due to regulation; for example, the Denied Boarding Compensation Regulation for airlines has been active in the European Union since February 2005, limiting the benefits and the applicability of bumping beyond what is needed to hedge against cancellations and no-shows. This shift paves the way for callable services that provide capacity providers with the flexibility of the bumping strategy without the ill-will of involuntarily denied customers.

2.1.5 Opaque services

Most of the fulfillment options discussed so far pertain to primary providers of capacity. In contrast, opaque services are mechanisms that allow flexibility to brokers selling capacity from different providers, often without revealing their sources. For opaque services, the identity of the service providers and some other service attributes are concealed from consumers until after purchase (Fay, 2008). For example, the opaque service may be accommodation in a certain city during a specified period of time, but the alternative hotels may be hidden from potential buyers. Primary capacity providers prefer to keep their identities opaque in order to mitigate demand cannibalization and potential adverse impact on brand image. The customer pays a discounted price for the opaque service and, once the purchase is completed, the reseller can assign to the customer any specific service that meets the revealed characteristics. Opaque selling is used in the travel industry by Hotwire and Priceline through which the customers can, for example, book a hotel room from Hilton, Sheraton or Marriott and the hotel identity is only revealed after purchase. The pricing models of the two firms are different — Hotwire offers a posted price for the opaque service, while Priceline uses the "Name Your Own Price" model where the customers place binding bids for the opaque service.

Jiang (2007) argues that opaque selling is a form of price discrimination through which firms can segment the market by charging a discounted price in the opaque market and a published full price in the full information market. Fay (2008) shows that opaque selling may lead to market expansion and reduce price rivalry, except in the case of industries with little brand loyalty.

From the customer's perspective, opaque services are similar to probabilistic goods (Fay and Xie, 2008) and flexible services, since in all these cases the customer faces uncertainty about which service he will eventually receive. The difference is that in the case of flexible services and probabilistic goods the customer knows the exact set of alternatives, and in the case of opaque services he does not.

Due to different incentives, flexible services are designed to be mostly sold by primary capacity providers, while opaque services are designed to be mainly offered by capacity brokers. Primary providers could also sell opaque services; however, since in this case all the alternatives in the opaque set would belong to the same capacity provider, the opaque services cannot be too deeply discounted without having a negative impact on the brand image. For example, upscale hotel chains with several hotels in the same city may be reluctant to offer a deeply discounted opaque service consisting of rooms in any of their hotels, when the difference between the opaque price and their full published price is too large. This creates an incentive for primary capacity providers to offer flexible rather than opaque services.

Similarly, flexible services could also be sold by capacity brokers by revealing the set of alternatives. However, primary providers may be unwilling to supply services if their identity is revealed, for example due to the existence of higher published prices for these services in the full information market. This creates an incentive for capacity brokers to offer opaque rather than flexible services.

Several topics of future research here include the tradeoff between the opaque price and the amount of information revealed prior to the purchase, the optimality of opaque selling under competition between several resellers of opaque services, and opaque selling strategies under models of customer learning and expectation formations.

2.2 Consumption options

Consumption options reflect buyer rights and are designed to preserve or enhance consumption flexibility. Some examples are refundability and exchangeability features. Consumption options are particularly relevant for services where advance booking is involved. Customers' service valuation typically changes over time. When purchase and consumption decisions are separated in time, buyers may not know at the time of purchase which alternative they will prefer at the time of consumption. Some of these customers may be willing to pay a premium to preserve choice flexibility. Indeed, Guo (2006) shows that buyer uncertainty about service valuation offers an incentive to reserve consumption flexibility by purchasing multiple items, a practice prevalent in many retail settings (for example, packaged goods). When the service price is high enough to preclude the purchase of multiple items, consumption flexibility can alternatively be ensured through the built-in features of the service itself. These consumption options allow the seller both to segment the customers according to their uncertainty about future service valuations, and to customize the services to better fulfill buyers' preferences.

2.2.1 Optional services

Optional services offer customers a menu of pre-specified alternatives to be selected at a given future period for consumption. For example, a customer could buy an optional opera ticket that would allow him to see a performance on either evening between April 13-15. Within a certain time period (say, a day) before the earliest performance date, the customer would have to decide on the chosen date and inform the theater of his choice. While the customer may be able to achieve the same outcome by buying just one refundable ticket for the most likely performance date and exchanging it later for a different date if the need arises, he would not have the guarantee to find capacity still available for the alternative performance dates at the time of the decision. Therefore, optional services add value by offering the guarantee that a seat would be available, and can thus be sold at a premium over all individual service prices.

From the customer's perspective, optional services are the mirror image of flexible services from the capacity provider's perspective. As in the case of callable and refundable services, the cost is incurred here by the party who has more flexibility — the buyer in the case of optional services sold at a premium, and the seller in the case of flexible services sold at a discount.

The choice of the alternative set for an optional service can belong both to the provider and to the customer. The seller may offer a "set menu" of optional services, or the buyer may build his own optional service at the time of purchase (and only a subset of the company's services may be available for inclusion in an optional service, as in the case of upgrades). Letting the customer design his own optional service makes more sense, and an interesting research question here is to optimize the price of optional services when they can be hedged by selling flexible and callable services.

2.2.2 Refundability options

A service can be fully, partially, or not at all refundable. For example, a partially refundable train or airline ticket may be sold as an (x, p, t) option where x is a non-refundable deposit that gives the right to the customer to travel by paying p at time t before departure. Ignoring the time-value of money, this option is equivalent to a total fare $x + p$ where p is refundable if the customer decides not to travel for any reason. The special cases $(x, 0, 0)$ and $(0, p, 0)$ correspond to non-refundable and fully refundable fares. Gallego and Sahin (2007a) show that the use of partially refundable fares can significantly increase revenues over the best capacity allocation between non-refundable and fully refundable fares. They also show that, properly used, options are socially optimal and provide a mechanism to allocate surplus between the consumers and the capacity provider. This result extends to the sale of different quality goods. In the supply chain management context, refundability options can be used as procurement options to hedge against uncertain demand. If demand turns out to be high then the options are exercised, otherwise the only cost is the non-refundable part. Gallego and Sahin (2007b) show that partially refundable fares are the only equilibria for the Stackelberg game between two providers. Moreover, they prove that the revenues obtained by using partially refundable fares Pareto-dominate the revenues from fully refundable fares.

Refundable services contracts can be used as an alternative to spot pricing to sell recurrent services with random costumer valuations and costs. Repair services are a good example. They are typically sold at spot prices or through warranties. Spot prices correspond to a contract of the type $(0, p(Z))$, where $p(Z) > Z$ is the repair price for a failure of random cost Z. Traditional warranties are of the form $(x, 0)$, where x is paid upfront to fully cover any qualified failure over a certain time horizon $[0, T]$. User heterogeneity makes traditional warranties expensive for low usage customers. This results in selection bias towards higher usage customers, which requires traditional warranties to be priced high (Hollis 1999). A "first-best" upper bound on expected profits from heterogeneous customers can be theoretically achieved if different options of the form (x_k, Z) were sold to customers with different usage rates. Here x_k is the upfront price paid by segment k customers that gives them the right to obtain repair services over $[0, T]$ at the actual random cost Z rather than at spot prices $p(Z)$. Unfortunately it is not possible to offer the menu (x_k, Z) without violating incentive compatibility constraints which are designed to make sure that customers prefer buying the contract designed for them. It is possible, however, to offer an optimal contingent contract where customers pay r upfront for the right to repair the *next* failure at the random cost Z. The upfront payment r is refundable up to the point of the next failure. By selecting r appropriately, it is possible to achieve the first-best expected profits, see Gallego (2010), when customers valuations are identically distributed and failure rates are heterogeneous. The key here is that r is designed to make it incentive compatible for customers to re-purchase the contingent contract after each failure. Customers with higher failure rates naturally pay more as they have to buy the contract more frequently.

2.2.3 Exchangeability options

A service can be fully, partially, or not at all exchangeable. Usually, exchangeability is not restricted in terms of alternatives, but it is subject to available capacity. The customer may need to pay a fixed exchangeability fee, plus the difference in price between the service bought initially and the desired service. An exchangeable service is thus sold as an (x, p, t) option where x is the exchangeability fee, p is the price of the original alternative chosen, and t is the time before fulfillment when the option expires. For example, a customer may pay p for a theater ticket for a performance on 15 April, with the option of exchanging it later (say, until 13 April) against a fee of x for a performance of the same play on a different day. The customer will also have to pay any difference in price between the ticket originally chosen and the new alternative. The special cases $(0, p, 0)$ and (∞, p, t) correspond to fully exchangeable and non-exchangeable services.

There are close links between exchangeability, refundability options, and optional services. A refundable service is also exchangeable, since the customer is reimbursed for the original purchase and may always choose to buy another service. The converse is not always true; a service can be fully exchangeable and non-refundable, as in the case, for example, of some train and airline tickets. Exchangeable services also differ from optional services; unlike optional services, where the customer buys the option of consuming any service of his choice from a set of alternatives without further cost, exchangeable services do not guarantee either that capacity for the desired alternative will be available, or that the price will be the same. To our knowledge, no research exists on the optimal design and pricing of broad service menus with different exchange options and fees.

2.3 Real options for access services

A particular case of real options inherently designed into services consists of access plans for services. One example is a three-part tariff (x, c, p), where customers pay a regular (eg., monthly) access fee x that covers an allowance c of a certain number of units access, after which they pay variable costs p depending on usage. The tariff (x, c, p) is commonly used in cell phone plans, the tariff (x, c, ∞) corresponds to calling cards, and the tariff $(x, \infty, 0)$ is practiced by gyms and golf club memberships that provide unlimited usage but may charge for ancillary services. The tariff $(x, 0, p)$ is common for warehouse clubs where the access fee gives the right to purchase goods at discounted price p. Certain professional or social clubs memberships are also of this form.

The real options embedded in access services induce an admission control problem for customers as they decide on usage levels, and can shape their purchasing and consumption behavior. For example, in the case of cell phone plans the customers' admission control problem consists of deciding whether or not to engage in a call at any time. Once the allowance is exhausted, the decision is simple because a customer would make or take a call only if its value exceeds the marginal cost p. However, prior to exhausting the allowance the problem of admitting calls is very similar to the admission control problem, known as revenue management, practiced by providers of perishable capacity, as their decisions are made in terms of the remaining capacity and time-to-go. Notice that the admission control policy that the customers would use as a result of solving their admission control problem affects the total volume of calls. This itself depends on the parameters of the calling plan. By modeling the customers' expected utility of a plan $U(x, c, p)$ and taking into account the distribution of customers in the population, providers can design a menu of tariffs (x_i, c_i, p_i), $i = 1, \ldots, n$ to maximize expected revenues subject to incentive compatibility and capacity constraints. The tariffs employed may be driven by optimality conditions or by business rules. For example, they can share a common value of p as is the case when selling cell phone plans.

The design and pricing of limited warranties also share similar features through embedded real options. Limited warranties allow a limited number of claims, and require customers to solve an admission control problem to decide whether or not to claim a failure. The solution to this problem allows issuers to understand their customers' expected costs and to design and price a menu of warranties with varying deductibles, co-pays, or claim limits. These warranty services would appeal to customers with different usage and therefore different failure rates. Since customers self-select from the menu of available warranties according to their estimated usage, these policies help avoid the problem of traditional warranties which lose money on high-usage customers if priced low, and lose market share if priced high. Notice that these types of warranties are related to three-part tariffs, in that they have an access fee and an allowance (number of claims) but they do not have a constant variable cost for failures out-of-warranty.

Residual value warranties are contracts with a refund schedule that depends on the number of failures that are claimed (Gallego et al., 2010). For example, the contract may offer a refund only if there are no claims, or offer a smaller refund if there are just one or two claims. Residual value warranties allow the providers to appeal to a large share of the market with one single service. Indeed, the net cost of these policies is low for low-usage customers (as they receive larger refunds) and higher for high-usage customers, again avoiding the problem of traditional warranties. The admission control problem for customers who purchase residual value warranties is to maximize the expected refund net of the cost of failures paid out-of-pocket. At the time of a failure, the customers should compare the out-of-pocket repair cost with the marginal cost to the refund schedule. Notice that these contracts are also related to three-part tariffs with options, in that they have an access fee, either a finite or an infinite allowance, and a refund schedule that depends on the number of claims.

The pricing and design of access services with real options should take into account the insights from the behavioral economics literature on customers' valuation processes, and their implicit models and biases. Some relevant references are the contract design article by DellaVigna and Malmendier (2006), the article on tariff-choice biases by Lambrecht and Skiera (2006), and the book by Rubinstein (1988) that attempts to model bounded rationality.

3 Bundling, Unbundling, and Versioning

Operational strategies for derivative services include bundling, unbundling, and versioning the service by adding or removing some of its features or by imposing usage or purchasing restrictions. In this section we discuss and illustrate these three strategies.

3.1 Bundling

Bundling is the practice of selling two or more services in a package. This is essentially a segmentation strategy based on the fact that varying customer segments have different valuations for combinations of services. Bundling is practiced across a wide range of services and it is often used as a strategic competitive tool (Stremersch and Tellis, 2002). Internet service providers offer bundles of web access, email, search and instant messaging software, and web hosting. A premium bank account is typically a bundle of separate savings and checking accounts, debit and credit cards, access to investment advice, retirement plans, insurance cover, and currency transactions (Koderisch et al., 2007). Restaurants offer fixed-price menus which are bundles of appetizers, main course and desserts that cost less than ordering à la carte[1] or may contain items not found on the regular menu. Orchestras, theaters, and sports teams bundle different concerts, performances or games tickets into season tickets. In the pharmaceutical industry, firms bundle their branded products with generics which are then sold to managed care buyers. In the transportation industry, any round trip ticket is effectively a bundle of two one-way tickets. Transportation companies offer bundles of different travel related services such as airport transfers, car rental, hotel accommodation, or activities at the destination such as museum visits and tour guides.

Properly priced, bundles can lead to increased sales and reduced costs. Producers often have decreasing costs through economies of scale from increased sales, and through economies of scope from bundling interrelated services. The savings are higher when bundling products with low marginal costs and high development costs such as software or information goods (Bakos and Brynjolfsson, 1999), than when bundling products with high marginal costs such as consumer durables. Cost savings are also relevant for consumers who face less choice complexity and may prefer the convenience of buying the bundle. Harris and Blair (2006) find that the consumers' preference for acquiring the bundle versus buying individual items is greater in the cases when choosing the bundle reduces search effort, particularly among consumers less motivated to process information.

In practice, there are two main forms of price bundling (Adams and Yellen, 1976). In *pure bundling* only the bundle is offered for sale and the component services cannot be bought individually. For example, European ski resorts during peak season only offer one-week accommodation packages, and weekend or single night accommodation in most hotels cannot be purchased separately. Pure bundling is often used to achieve certain strategic objectives. Microsoft created a pure bundle of its Internet Explorer software with its Windows operating system — this was a major issue in the Microsoft antitrust case, but it allowed the company to increase its share of the web-browsing market from 7% in mid 1996 to more than 90% in 2007. In the pharmaceutical industry, Pfizer planned to bundle its new heart treatment drug Torcetrabip with Lipitor, the company's best selling cholesterol lowering drug (The New York Times, March 7, 2005), and this pure bundling strategy would effectively extend the patent of Lipitor. Pure bundling is also sometimes used to sell distressed inventory whose potential to be sold at a normal price has passed or will soon pass. For example, by offering a pure bundle of hotel rooms and air tickets, capacity providers

[1] These bundles may have a quantity discount component built into them.

can sell distressed inventory at a lower price without offering that price to customers who are only interested in the hotel or in the air tickets.

In *mixed bundling* both the bundle and the individual services are offered for sale. Often, consumers pay the full price for a first "leader" product (usually an innovative product) and receive a discount for additional (usually mature) products. *Value-added bundling* is a variation on mixed bundling; instead of offering a discount on the bundle, the firm builds-in an additional feature that is attractive to price-sensitive customers and that may be sold only with the core service (for example, car vacuuming as an add-on service to a car wash). Consumer rebates can also be seen as a special form of mixed bundling; with the aim of fostering customer loyalty, companies sometimes offer consumers a rebate on the total sales across all company's products in a certain time frame. Fuerderer et al. (1999) note that these sales rebates can be seen as a mixture of bundling and nonlinear pricing.

The bundle design and pricing problem consists of determining which attributes or components are included in each bundle, and to price each bundle optimally to maximize profits; see Oren [this volume]. Customers are often assumed to be utility maximizers who select among the bundles and the no purchase alternative. In addition, bundle prices need to be constrained in order to be efficient, in the sense that customers cannot reconstruct them at a lower price by purchasing more primitive bundles (Hanson and Martin, 1990).[2] The efficiency constraint greatly complicates the bundle design and pricing problem.

When customers have utilities that are linear in the attributes, Gallego (2009) shows that bundles are efficient if and only if there exists a positive vector of attribute prices. This reduces the problem to that of designing the bundles (i.e., choosing the individual service components) and pricing their components. Then bundle prices are simply the sum of the prices of the component services. As an example, consider the case of four market segments $l = 1, \ldots, 4$ with sizes λ_l and valuations v_{li} for three attributes $i = 1, 2, 3$. The attribute costs are c_i, $i = 1, 2, 3$. The values of the

[2]The efficiency constraint may be relaxed if there are significant costs associated with reproducing bundles (Harris and Blair, 2006). For example, a customer flying from Berlin to San Francisco may be presented with several connecting itineraries. Each connecting itinerary is essentially a bundle of the different flight legs involved. It is sometimes possible for a customer to pay less by separately buying the flight legs, but this involves higher search and transaction costs. In this case bundles may be purchased even if they can be reproduced at a lower price, because of the convenience factor and because being presented with a single bundle price lowers price sensitivity (Yadav and Monroe, 1993).

l	v_{l1}	v_{l2}	v_{l3}	λ_l
1	5	12	45	100
2	4	8	40	120
3	3	10	0	150
4	0	11	43	120
c	3	8	30	

Table 1: Four market segments, three attribute example

parameters are as given in Table 1. If bundling is not allowed, the provider needs to optimize the price of each attribute and allow customers to select à la carte the attributes they desire. The optimal à la carte attribute prices can be shown to be given by the vector $q = (4, 10, 40)$. Given these prices, customers select attribute i if and only if $v_{li} \geq q_i$, $l = 1, 2, 3, 4$. Customers in segments $l = 1, 2, 3, 4$ will thus buy the bundles $(1, 1, 1), (1, 0, 1), (0, 1, 0)$ and $(0, 1, 1)$ respectively, paying 54, 44, 10 and 50 for them. Under this pricing scheme the provider's profit is $4,360, and market segments 1 and 4 enjoy surpluses of 8 and 4 respectively. When bundling the services as described in Table 2, it is possible to reduce the surplus of market segments 1 and 4 to zero by giving up the profits from market segment 3. This results in a 22.5% improvement in profits. The internally consistent vector of attribute prices is now $q' = (8, 18, 36)$, so the price of any of the offered bundles is just the sum of the attribute prices. However, customers should not be allowed to buy à la carte at q' as this results in very low profits of $2,040 and defeats the purpose of bundling.

l	y_{l1}	y_{l2}	y_{l3}	price	profits
1	1	1	1	62	2,100
2	1	0	1	44	1,320
4	0	1	1	54	1,920
total					$5,340

Table 2: Efficiently priced bundles

Hanson and Martin (1990) develop a bundle design and pricing model that can accommodate multiple components and a range of cost and reservation price conditions. Mussa and Rosen (1978) study the problem of nonlinear pricing and product line design in a monopolist setting, and Rochet and Chone (1998) extend this analysis to the multidimensional case where consumers types have different distributions. In a different stream of literature, behavioral research has investigated how consumers evaluate bundles. Most of the studies focus on how bundles are processed, particularly from a prospect theory or mental accounting perspective. Yadav and Monroe (1993) show that presenting customers with a single bundle price lowers price sensitivity and increases purchase likelihood, while Johnson, Herrmann and Bauer (1999) find that consumers perceive multiple savings in the bundle as more favorable than a single saving. The firm should therefore give customers a single bundle price rather than a list of separate service prices, and it should present the bundle discount as multiple savings. This strategy may affect not just consumers purchasing decision, but also their consumption behavior; Soman and Gourville (2001) show that customers who buy a bundle at a single bundled price consume less than those who buy when presented with separate service prices. This finding may in turn have implications for overbooking policies in the travel and leisure industries. For example, the seller could improve the forecasts of cancellations and no-shows based on information relative to the bundles sold, and therefore adjust the overbooking levels accordingly.

The problem of optimal bundle pricing is implicitly linked to the question of estimating the customers' valuation of bundles. This in turn is an area of research with strong links with behavioral economics, a branch of economics that applies research on human cognitive and emotional factors to understand how consumers make decisions and how these affect market prices. The primary concerns are with bounded rationality (Simon, 1987) and with integrating psychology and economic theory. This subfield owes much to prospect theory developed by Kahneman and Tversky (1979) who compared cognitive models of decision making under risk and uncertainty with economic models of rational behavior.

Ariely (2008) claims that people are not only irrational but predictably so, and gives several pricing examples where people act irrationally in a predictable way. One of these examples deals with the price for *The Economist*, a popular British magazine. *The Economist* offers a paper-only subscription, an internet-only subscription, and a bundle consisting of both subscriptions. The price of the bundle equals the price of the paper subscription and it is significantly higher than the price of the internet subscription. In experiments with students, Ariely noticed that excluding the paper-only option biases the decision towards the cheaper internet subscription, while the presence of the paper-only option biases the choice towards the bundle. From this experiment, Ariely developed and tested the hypothesis that people can be influenced in their choice between alternatives A and B by adding an alternative that is slightly inferior to the one the experimenter wants people to select. In *The Economist* example, adding the inferior paper-only subscription led to a bias toward the bundle. While this seems an ingenious way of steering predictably irrational customers towards buying the bundle, the strategy of offering the paper-only subscription and the bundle at the same price is actually consistent with pricing under the multinomial choice model in the likely case that the marginal cost of offering the internet-only subscription is zero (Gallego and Stefanescu, 2007). Offering a free product with the sale of another can be an effective way to increase sale volumes without discounting either of the products. Apple practices this by offering a free iPod Touch with the purchase of a MacBook laptop. In principle, some of Ariely's research can be used to design and price bundles taking into account irrational consumer behavior; see Özer and Zheng [this volume].

3.2 Unbundling

Unbundling is the strategy of separating the base service from the supplementary options and charging separate prices for each part of the service. For example, online music services such as iTunes unbundle by letting customers buy individual songs rather than complete CDs (Winer, 2005). Airlines routinely unbundle luggage handling services from the ticket offers. In the finance industry, the unbundling practice of stripping bonds into a series of zero coupon bonds has met with great success. In the software industry, the SPSS software package was unbundled in the mid 1980s, allowing customers to purchase individual SPPS modules. Humphrey (2002) also describes the unbundling practices at IBM. Unbundling is primarily motivated by psychological research showing that unbundled prices may sometimes result in higher service valuations and greater purchase likelihood (Chakravarti et al., 2002).

3.3 Versioning

Service versioning is an operational strategy whereby the firm offers a product line based on different versions of a core service (Kahin and Varian, 2000). More specifically, lowering the quality of a product to sell it to different customers is a part of this strategy also known as product damaging or product crimping (Deneckere and McAfee, 1996; McAffee, 2002). The objective is to appeal to price sensitive customers who would not normally purchase the product at its regular price.

Examples of lowering product quality are slowing the speed of computer chips in semiconductor manufacturing, slowing the mail delivery, or offering uncomfortable seats for transportation[3], entertainment or sporting events. In the early 1990s IBM introduced an E model of its laser printer that printed at half the speed of the regular model. In industries that practice advance selling, lowering service quality can be achieved by imposing purchase timing restrictions (e.g., some tickets can only be bought two weeks before the event). In the transportation industry, lowering service quality usually involves imposing travel restrictions in the form of minimum, maximum, or mandatory stays. It should be noted that fare design in the airline industry mostly centered on service versioning by imposing fences such as advance purchasing and Saturday night stays on low fares. The ultimate outcome of these strategies is a product line with a range of "inferior" to "superior" products which is very common. There is a vast literature on this topic that includes tactics such as selling different grades of gasoline, different printer types, different classes of rental car, paperback vs. hardback books, different qualities of liquor, etc. even when some of the products sold as "inferior" are identical or damaged versions of the "superior" product, see Phillips (2005, page 82-83).

The notion of versioning can be combined with the concepts of bundling and unbundling. As an example, let us reconsider the unbundling of luggage services that helped airline profitability in 2009. Airlines could version luggage handling by selling a premium service that gives luggage priority and thus decreases pick-up time at destinations. As another example, consider Southwest Airlines versioning of the plane boarding process. As many airlines do, Southwest gives free priority boarding to elite members. However, Southwest also sells boarding priority to non-elite passengers. Buying this priority is important since Southwest uses an open seating system instead of pre-assigning seats. Passengers arrange themselves into queues at the airport and take their preferred open seat once aboard. Queue A boards first, then B, and then C. Within each queue, passengers board according to a pre-assigned number; they also queue in specially designed areas which helps to speed up boarding. "The slight rush by passengers to claim a seat once they are on the plane actually speeds the process along...", says CEO Gary C. Kelly (New York Times 2007). Currently Southwest ranks ninth out of 18 airlines in on-time arrivals (U.S. Department

[3]The 19th Century French economist Emile Dupuit wrote about third-class carriages built without roofs that "... what the company is trying to do is prevent the passengers who can pay the second-class fare from traveling third class; it hits the poor, not because it wants to hurt them, but to frighten the rich"; Ekelund (1970).

of Transportation 2010), which helps to reduce the cost of airline delays currently estimated to be 32 billion dollars per year (Washington Post 2010).

4 Applications: Revenue Management and Customer Relationship Management

Designing service features for market segmentation is often used in both revenue management (RM) and in customer relationship management (CRM). In this section we discuss actual and potential applications of service feature designs for both RM and CRM. We then point to some opportunities at the intersection of customer relationship and revenue management (CR^2M).

Revenue management refers to techniques to optimally or near-optimally allocate capacity among different fare classes to maximize expected revenues from perishable resources; see Talluri [this volume]. Revenue management originated in the airline industry but its use has spread to hotels, car rental, restaurants and other industries where capacity is reserved. In the airline industry the resources are the seats over the network. There may be several fares associated with an itinerary. A fare is a combination of a price and a set of restrictions such as advance purchase, Saturday night stay, and limited seat selection. This is in essence service versioning with the caveat that demands are random and the allocation to lower fares needs to be done before observing demand for higher fares. In addition, the very realization of demand depends on the admission control policy used. This is because as fares are closed customer demand may shift to other fares or may be lost. Cancellations and no-shows complicate the problem and are mitigated by the systematic use of capacity overbooking. At a strategic level RM is also about designing fares and setting competitive prices. Fare designs based on service versioning combined with overbooking and capacity allocation together provided a successful formula for airlines and other industries practicing RM. However, the presence of low-cost-carriers (LCCs) that do not impose purchase restrictions is dramatically diminishing the benefits of RM for competing traditional carriers.

It is therefore critical for the airline industry to find new ways to segment customers based on attributes other than purchase restrictions. One initiative that is gaining traction with some providers is the unbundling of the core service (transportation from an origin to a destination) from ancillary services such as luggage handling, meals, mileage accrual or advance seat selection. These providers are now selling these services à la carte. On the other hand, airlines such as Air Canada cater to different market segments through bundles of branded services such as Tango, Tango Plus, Latitude, and Executive. Unbundling and bundling ideas are also used in the rental car industry. For example, mileage may be unbundled in situations where roads are harsh, while insurance may be mandatory for certain destinations. In addition, cars can be bundled with gas and features such as GPS or satellite radios. Hotels sometimes include breakfast and transportation, but may unbundle gym access and luggage storage for deeply discounted fare bookings.

Real options can also be used in RM to segment customers. On the fulfillment side, overbooking and upgrades are practiced in a variety of industries that practice RM. Opaque services are successfully used to sell distressed inventories, often as stand alone services but also in bundles that combine air transportation with hotels and car rentals. On the consumption side, refundability and exchangeability options are often used in a crude way by the airlines, most of which only sell fully refundable or non-refundable fares. Designing and pricing partially refundable fares, however, may be a profitable way to help customers manage consumption risk. Such fares are currently offered by some train companies including the Deutsche Bahn and the French SNCF. Exchangeability fees tend to be fixed, but there is the potential to make them fare class dependent. As as an example, Air Canada has lower exchangeability fees on their highest priced bundles. Flexible services are used in variety of industries, most prominently in cargo but also in car rentals (a class of cars is booked, any of which can be used to fulfill the request). Tour operators sell tours where a certain hotel class is promised, together with a list of possible hotels that can be used to fulfill the contract. In advertising, most ads are sold as flexible services as advertisers pay for impressions but publishers decide where ads are placed. Callable services, called preempting, are often used in Internet advertising where cost per action (CPA) or per click (CPC) are discounted in contracts that allow publishers to choose not to deliver ads if more valuable future contracts are formed. Callable services have the potential to reduce overbooking costs and improve capacity allocation in the travel industry. They may also help mitigate the formation of secondary markets in the entertainment industry.

Customer relationship management is the practice of tracking customer behavior in order to develop marketing programs bonding consumers to a brand, with the goal of maximizing long-term profitability. CRM strategies include tailoring the service delivery process to the specific preferences of individual customers, and developing customized marketing communications. CRM is particularly common in the hospitality industry where hotels endeavor to foster customer loyalty. CRM techniques are also used in the gaming industry to identify individual preferences, demographics, gaming propensity, psychographic profiles and other behavior measures of casinos customers that allow to assess a customer's overall profitability. On this basis of expected profitability casinos can customize service features such as discounted rooms, upgrades, complimentary airport transportation, free meals and drinks, and other ancillary services. Offering discounts and free services can create tension with RM systems designed to myopically extract the maximum expected profit from limited resources. To resolve this tension, RM systems need to incorporate the expected customer lifetime value.

A successful implementation is reported in Metters et al. (2007) who discuss the case of Harrah's Entertainment, the current CR^{2}M leader in the gaming industry. Their "Total Rewards" program tracks customer play across all properties and captures detailed customer information used to compute the lifetime value. The company uses around 100 customer segments based on lifetime values and varies the rates and room availabilities, rewards and promotional messages by segment. This practice has increased revenue per room across the hotel chain by 15%, compared to an average 3% to 7% in other industries. Metters et al. (2007) note that the goal of Harrah's is to have a full hotel with an average room rate of $0/night, while the bulk of the revenue is generated by gambling. CR^{2}M strategies have also been explored in the airline industry, for example by using customer no-show information to improve forecasts of seat availability on a given flight. Jonas (2001) notes that CR^{2}M for airlines could add from 4% to 33% in incremental revenue, with an estimated average of 8%.

Substantial benefits can be derived from CR^{2}M in several industries. The main idea is to manipulate the mix of services and prices offered by the seller based on characteristics of individual customers (in particular on their specific profitability) rather than on customer segments. The scant literature on CR^{2}M focuses mostly on applications in specific industries. Lieberman (2002) discusses the integration of revenue management with personalized marketing techniques. Noone, Kimes and Renaghan (2003) investigate the relationship between CRM and RM in the hospitality industry. Using the lifetime/profitability approach to customer segmentation, they identify appropriate customer segments for targeting with CRM techniques and outline a supporting RM strategy for each segment, including traditional RM, lifetime value-based pricing, availability guarantees and short-term and ad hoc promotions. Hendler and Hendler (2004) provide an overview of CRM in gaming, and discuss how RM may be implemented in casinos alongside CRM to decide on effective room allocation and to maximize the overall property revenue. They note that allocating rooms is a main challenge for RM in gaming, where hotels must ensure that rooms are available for the most profitable segments but assessing customer profitability is not trivial. As Pilon (2008) points out, customer-centric RM would be discriminatory at the service availability level, since availability would depend on the profitability of the customer requesting the service, including his propensity of ancillary spend.

CR^2M is greatly facilitated by electronic commerce. In particular, electronic booking engines have the advantage of easy upselling (the situation when the seller offers service additions, including free upgrades) and cross-selling (when the seller offers service alternatives). In addition, the seller may offer customized subscriptions based on profiling (some examples are patronage programs used by leading cultural venues such as opera houses and concert halls). One of the main challenges in implementing CR^2M in an electronic commerce framework lies in finding techniques for handling multiple profiles that arise, for example, when customers browse for tickets without logging through registered profiles. This is a special case of the broader issue of correctly identifying customers that enter a transaction through different channels than those used for the loyalty programs, leading to the need for developing models for multi-channel shopping.

Great potential lies also at the intersection of supply chain management and CR^2M. We have previously discussed the practice of customizing prices to preferred lead times. This is an example of a broader strategy that incorporates contract designs, shared forecasting, and capacity planning. For more insights, see Özer and Wei (2006), and Boyaci and Özer (2010).

5 Conclusions and Future Research

In this chapter, we discussed service engineering strategies that are or could be used successfully to increase profits and market share in a broad range of industries. Real options, bundling/unbundling, and versioning help broaden and segment markets. For providers, service engineering strategies promise to boost market share and improve capacity utilization and profits. Customers could benefit from a greater array of customized services that align better with their specific consumption needs and willingness-to-pay. Table 3 shows how these strategies could apply to industries as varied as travel and leisure, digital media and gaming, and utilities and pharmaceuticals (Tran, 2010).

Table 3: Design and Pricing of Service Features by Industry

	Real Options									Product Redesign			CRM
	Callable Products	Flexible Products	Upgrades/ Upsells	Bumping	Opaque Products	Optional Products	Refund-ability	Exchange-ability	Access	Bundling	Unbundling	Versioning	
Travel	P	X	X	X	X	P	X	X	X	X	X	X	X
Leisure	P	X	X	X	X	P	X	X		X		X	P
Hotel & Hospitality	P	P	X	X	X	P	X	X	P	X	X	X	X
Entertainment Tickets	P	P	X		P	P	P	P	X	X		X	X
Internet Advertising	X	X	X		X		X			X			P
Technology		P	X		P		X		X	X	X	X	P
Digital Media & Gaming									X	X	X	X	
Utilities		X							P				
Transport & Supply Chain	X	X	X	X	P	X	X	X		X	X	X	P
Insurance									X	X	X	P	P
Finance		X				X			X	X	X	X	
Pharmaceuticals			X		P		P			X		X	
Car Rental	P	P	X	X	X		X	X	X	X	P	X	P
Club Memberships									X	X	X	P	P

Key: X = In use; P = Possible opportunity

Many challenges remain before we see widespread implementation of robust service engineering strategies. From the technical perspective, the most important challenges involve information technology, forecasting, and pricing. Most companies lack the appropriate information technology to implement many derivative services. For example, the airline industry has not yet adopted ticket options mainly because its legacy systems are unable to handle the data requirements. Similarly, corporations need to update their accounting systems to recognize adequately non-traditional revenue streams. Optimally pricing new offers also presents hurdles, due to both the increased complexity of service features and the need to develop more sophisticated models of market demand. Demand forecasts, after all, are essential components of pricing models. In the case of non-traditional services, such forecasts may be difficult to construct without relevant past sales data.

Fortunately, the growth of Internet sales has greatly facilitated data collection and management through automated tools, enabling more complex and accurate demand modeling at lower levels of aggregation. In the past, many industries based their pricing strategies on models of aggregate demand at different pricing levels, assuming that demand from segment of the market was independent of the other. With the availability of customer-level purchase data, these models are being replaced slowly by dependent demand models that account for consumer choice and can predict a customer's purchase likelihood based on buyer and service characteristics (Talluri and van Ryzin, 2004; Gallego, Iyengar and Phillips, 2006; Liu and van Ryzin, 2008; Gallego, Lin and Ratliff, 2009).

Of course, providers must not only predict demand but generate it as well. In terms of marketing, they must help consumers understand how engineered services help them manage consumption risk and put a value on their own consumption flexibility. As in the financial industry, intermediaries—think of them as brokers—may play a critical role in educating customers. These intermediaries may help customers understand how to align derivative services with their needs, as well as provide tools for sophisticated customers to self-select services. Some potential customers may initially balk at price segmentation strategies. Brokers must find creative ways to frame engineered services by discussing their consumer benefits while explaining their potential costs.

Many of these challenges were first faced by firms that embraced financial engineering during its incipient stages. They went on to overcome many of these implementation issues. Today, financial engineering benefits both practitioners and consumers by spreading market risk and allowing capital to flow more efficiently. Service engineering can achieve similar improvements in risk reduction and demand generation, benefiting providers and consumers alike. As in the case of financial engineering, however, there are also the underlying dangers of the inappropriate use of some of these strategies. By studying the lessons of the 2007-2009 credit crisis, future service engineers may learn how to better manage derivatives and prepare for potential extreme events.

One promising area of future research lies in the use of service engineering to design and price large service contracts. These might include outsourcing information technology or payroll, or setting up service call centers, or hiring temporary workers for large projects. Negotiations for such large deals may last many months and involve a delicate balancing act. On one hand, service providers must manage the sales funnel to maximize profit from conversion (or similar objectives). On the other, they must be able to allocate resources, including employees and contractors, in order to ramp up quickly once they close on a deal. Real options on projected resource requirements, including both equipment and personnel, can help fulfill such large deals without forcing service suppliers to overinvest in capacity. The pricing of a deal can be tied to fulfillment flexibility, customer options, and quality of service guarantees.

References

[1] Adams, W.J. and J.L. Yellen. (1976). 'Commodity Bundling and the Burden of Monopoly'. *Quarterly Journal of Economics*, 90: 475–498.

[2] Ariely, D. (2008). *Predictably Irrational.* London: Harper Collins.

[3] Bakos, Y. and E. Brynjolfsson. (1999). 'Bundling Information Goods: Pricing, Profits and Efficiency'. *Management Science*, 45: 1613–1630.

[4] Biyalogorsky, E., and E. Gerstner. (2004). 'Contingent Pricing to Reduce Price Risks'. *Marketing Science*, 23: 146–155.

[5] Biyalogorsky, E., E. Gerstner, D. Weiss, and J. Xie. (2005). 'The Economics of Service Upgrades'. *Journal of Service Research*, 7: 234–244.

[6] Boyaci, T. and Ö. Özer. (2010). 'Information Acquisition for Capacity Planning Via Pricing and Advance Selling: When to Stop and Act?'. Forthcoming in *Operations Research.*

[7] Chakravarti, D., R. Krish, P. Paul, and J. Srivastava. (2002). 'Partitioned Presentation of Multicomponent Bundle Prices: Evaluation, Choice and Underlying Processing Effects'. *Journal of Consumer Psychology*, 12: 215–229.

[8] Chen, F. (2001). 'Market Segmentation, Advanced Demand Information, and Supply Chain Performance'. *Manufacturing and Service Operations Management*, 3: 53–67.

[9] Della Vigna, S. and U. Malmendier. (2006). 'Paying Not to Go to the Gym'. *American Economic Review*, 96: 694–719.

[10] Deneckere, R. and R.P. McAfee. (1996). 'Damaged Goods'. *Journal of Economics and Management Strategy*, 5: 149–174.

[11] Ekelund, R. (1970). 'Price Discrimination and Product Differentiation in Economic Theory: An Early Analysis'. *Quarterly Journal of Economics*, 84: 268–78.

[12] Fay, S. (2008). 'Selling an Opaque Product Through an Intermediary: The Case of Disguising One's Product'. *Journal of Retailing*, 84: 59–75.

[13] Fay, S. and J. Xie. (2008). 'Probabilistic Goods: A Creative Way of Selling Products and Services'. *Marketing Science*, 27: 674–690.

[14] Fisher, M. (1997). 'What is the Right Supply Chain for Your Product?'. *Harvard Business Review*, March-April: 105–116.

[15] Fuerderer, R, A. Herrmann, and G. Wuebker. (1999). *Optimal Bundling: Marketing Strategies for Improving Economic Performance*. Berlin: Springer.

[16] Gallego, G. (2009). 'Design and Pricing of Efficient Bundles'. Working paper, Columbia University.

[17] Gallego, G. (2010). 'Contingent Contracts for Repeated Services'. Working paper, Columbia University.

[18] Gallego, G., M. Hu, R. Wang, J. Ward, J. Beltran, and J. Shailendra. (2010). 'No Claim? Your Gain: Price Discrimination Through a Residual Value Warranty'. Working paper, Columbia University.

[19] Gallego, G., G. Iyengar and R. Phillips. (2006). 'Revenue Management of Callable Products in a Network'. Working paper, Columbia University.

[20] Gallego, G., S.G. Kou, and R. Phillips. (2008). 'Revenue Management of Callable Products'. *Management Science*, 54: 550–564.

[21] Gallego, G., Lin, L. and R. Ratliff. (2009). 'Choice-Based EMSR Methods for Single-Leg Revenue Management with Demand Dependencies'. *Journal of Revenue and Pricing Management*, 8: 207–240.

[22] Gallego, G., and Ö. Özer. (2001). 'Integrating Replenishment Decisions with Advance Demand Information'. *Management Science*, 47: 1344–1360.

[23] Gallego, G. and R. Phillips. (2004). 'Revenue Management of Flexible Products'. *Manufacturing and Service Operations Management*, 6: 321–337.

[24] Gallego, G. and O. Sahin. (2007a). 'Revenue Management with Partially Refundable Fares', *Operations Research*, 4: 817–833.

[25] Gallego, G. and O. Sahin. (2007b). 'Duopoly Competition with Partially Refundable Fares'. Working paper, Columbia University.

[26] Gallego, G. and C. Stefanescu. (2007). 'Upgrades, Upsells and Pricing in Revenue Management'. Working paper, London Business School.

[27] Guo, L. (2006). 'Consumption Flexibility, Product Configuration, and Market Competition'. *Marketing Science*, 25: 116–130.

[28] Hanson, W.A. and R. Kipp Martin. (1990). 'Optimal Bundle Pricing'. *Management Science*, 36: 155–174.

[29] Happel, S. and M. Jennings. (1998). 'Assessing the Economic Rationale and Legal Remedies for Ticket Scalping'. *Journal of Legislation*, 16: 1–14.

[30] Harris, J. and E.A. Blair. (2006). 'Consumer Preference for Product Bundles: The Role of Reduced Search Costs'. *Journal of the Academy of Marketing Science*, 34: 506–513.

[31] Hendler, R. and F. Hendler. (2004). 'Revenue Management in Fabulous Las Vegas: Combining Customer Relationship Management and Revenue Management to Maximise Profitability'. *Journal of Revenue and Pricing Management*, 3: 73–79.

[32] Hollis, A. (1999). 'Extended Warranties, Adverse Selection and Aftermarkets'. *Journal of Risk and Insurance*, 66: 321-343.

[33] Humphrey, W. (2002). 'Software Unbundling: A Personal Perspective'. *IEEE Annals Of The History Of Computing*, 24: 59–63.

[34] Jiang, Y. (2007). 'Price Discrimination with Opaque Products'. *Journal of Revenue and Pricing Management*, 6: 118–134.

[35] Johnson, M.D., Herrmann, A. and H.H. Bauer. (1999). 'The Effects of Price Bundling on Consumer Evaluations of Product Offerings'. *International Journal of Research in Marketing*, 16: 129–142.

[36] Jonas, D. (2001). 'Carriers Melding Revenue Management and CRM Systems'. *Business Travel News*, 26th March, 18–19.

[37] Kahin, B. and H.R. Varian (Editors). (2000). *Internet Publishing and Beyond: The Economics of Digital Information and Intellectual Property*. Cambridge, MA: The MIT Press.

[38] Kahneman, D., and A. Tversky. (1979). 'Prospect Theory: An Analysis of Decision Under Risk'. *Econometrica*, 47: 263–291.

[39] Koderisch, M., G. Wuebker, J. Baumgarten, and J. Baillie. (2007). 'Bundling in Banking — A Powerful Strategy to Increase Profits'. *Journal of Financial Services Marketing*, 11: 268–276.

[40] Lambrecht, A. and B. Skiera. (2006). 'Paying Too Much and Being Happy About It: Existence, Causes and Consequences of Tariff-Choice Biases'. *Journal of Marketing Research*, 43: 212–223.

[41] Lieberman, W.H. (2002). 'Revenue Management: What Lies Ahead?'. *Journal of Revenue and Pricing Management*, 1: 189–195.

[42] Liu, Q., and G. van Ryzin. (2008). On the Choice-Based Linear Programming Model for Network Revenue Management'. *Manufacturing and Service Operations Management*, 10: 288–310.

[43] McAfee, R.P. (2002). *Competitive Solutions: The Strategist's Toolkit*. Princeton, NJ: Princeton University Press.

[44] Metters, R., Crystal, C., Ferguson, M., Harrison, l., Higbie, J., Ward, S., Barfield, B., Farley, T., Kuyumcu, A. and A.R. Duggasani. (2007). 'The "Killer Application" of Revenue Management: Harrah's Cherokee Casino & Hotel'. Working paper, Emory University.

[45] Mussa, M., and S. Rosen. (1978). 'Monopoly and Product Quality'. *Journal of Economic Theory*, 18: 301–317.

[46] New York Times, September 20, 2007. `http://www.nytimes.com/2007/09/20/business/20air.html`.

[47] Nagle, T. and R. Holden. (1995). *The Strategy and Tactics of Pricing.* Prentice Hall, New Jersey.

[48] Nelson, P. (1970). 'Information and Consumer Behavior'. *Journal of Political Economy*, 78: 311–329.

[49] Noone, B.M., Kimes, S.E. and L.M. Renaghan. (2003). 'Integrating Customer Relationship Management and Revenue Management: A Hotel Perspective'. *Journal of Revenue and Pricing Management*, 2: 7–21.

[50] Ö. Özer. (2003). 'Replenishment Strategies for Distribution Systems Under Advance Demand Information'. *Management Science*, 49: 255–272.

[51] Özer, Ö. and W. Wei. (2006). 'Strategic Commitments for an Optimal Capacity Decision Under Asymmetric Forecast Information'. *Management Science*, 52: 1239–1258.

[52] Phillips, R. (2005). *Pricing and Revenue Optimization.* Stanford University Press.

[53] Pilon, R. (2008). 'Integrating RM and CRM – A Myth or a Must?'. *AGIFORS RM & Cargo Conference*, Tahiti.

[54] Post, D. (2010). 'Variable Opaque Products in the Airline Industry: A Tool to Fill the Gaps and Increase Revenues', *Journal of Revenue and Pricing Management*, 9: 292–299.

[55] Rochet, J.C., and P. Chone. (1998). 'Ironing, Sweeping, and Multidimensional Screening'. *Econometrica*, 66: 783–826.

[56] Rubinstein, A. (1988). *Modeling Bounded Rationality.* Zeuthen Lectur Book Series, Karl Gunnar Persson, editor.

[57] Shugan, S. (2005). 'Marketing and Designing Transaction Games'. *Marketing Science*, 24: 525–530.

[58] Simon, H. (1987). 'Behavioural Economics'. *The New Palgrave: A Dictionary of Economics*, 1: 221–24.

[59] Soman, D. and J.T. Gourville. (2001). 'Transaction Decoupling: How Price Bundling Affects the Decision to Consume'. *Journal of Marketing Research*, 38: 30–44.

[60] Stremersch, S. and G.J. Tellis. (2002). 'Strategic Bundling of Products and Prices: A New Synthesis for Marketing'. *Journal of Marketing*, 66: 55–72.

[61] Talluri, K., and G. van Ryzin. (2004). 'Revenue Management Under a General Discrete Choice Model of Consumer Behavior'. *Management Science*, 50: 15–33.

[62] Tran, A. (2010). 'Service Engineering Applications'. Summer Project, Columbia University.

[63] U.S. Bureau of Transportation Statistics (2010). See: Profitability: `http://www.transtats.bts.gov/Data_Elements.aspx?Data=6` and Baggage Fees (Table 1C): `http://www.bts.gov/press_releases/2010/bts021_10/html/bts021_10.html`.

[64] U.S. Department of Transportation (2010). Air Travel Consumer Report.

[65] Winer, R. (2005). *Pricing*. Cambridge, MA: Marketing Science Institute.

[66] Washington Post. October 19, 2010. Air travelers found to lose billions to delays.

[67] Yadav, M.S. and K.B. Monroe. (1993). 'How Buyers Perceive Savings in a Bundle Price: An Examination of a Bundle's Transaction Value'. *Journal of Marketing Research*, 30: 350–358.