Patterns of Innovation in Service Industries

by

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Submitted to the System Design and Management Program
in Partial Fulfillment of the Requirements for the Degree of

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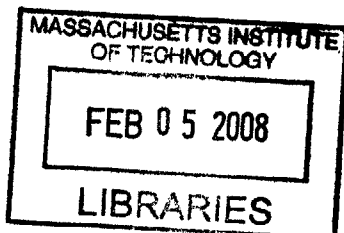
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ABSTRACT

Over the years, scholars studying technology-based innovation have uncovered patterns of success and failure. Many of the lessons learned from these observations can serve as powerful guidelines for leaders of industry as they guide their firms into new markets or help defend against emerging challengers. Most of the studies to date, however, have been based on research in manufactured product industries, while relatively little has been done to understand technology and innovation in service industries.

The initial motivation behind this thesis was to interpret established principles of innovation in the context of services-based industries. In proposing this topic, I assumed that certain aspects of product-based principles also describe patterns in service industries. My research revealed that some principles apply to both sectors. Others need to be extended. Still others apply selectively, depending on the nature of the service that is being examined. In the process of synthesizing the lessons learned from my literature review and the case studies I examined, Professor James Utterback pointed me to the convergence of product and services and the role of product platforms in this paradigm. What emerged was the idea of a technology delivery platform and throughout the latter parts of this thesis, I explore different implications of this concept.

Thesis Supervisor: James M. Utterback
Title: David J. McGrath jr (1959) Professor of Management and Innovation

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Chapter 1:
Introduction

Innovation and the rippling effects that it has on industries do not occur by chance. This notion has been studied in some detail by scholars and is of great interest to industry practitioners. Innovation theorists often assume that the flow of technology and information among markets and enterprises (e.g., customers and firms, manufacturers and their partners, etc) is the key impetus to the innovation process.

Over the past few decades, the creative and destructive effects of innovation on industries have been of particular interest. It has been observed that both entrepreneurs (Antonelli *et al.*, 1992) and large, established enterprises (Schumpeter, 1942) play a role in disruptive innovation. While one might think that only the largest firms can sustain the investment in R&D that is required to acquire breakthrough scientific knowledge, examining cases of discontinuous change suggests that differences in technological resources do not discriminate between large or small, new or established firms.

From studying discontinuous change, it has been observed that established firms tend to continue making heavy commitments in the development of old technologies, even when it is clear that a new technology is threatening. Scholars explain this phenomenon by suggesting that established firms are tightly tied to the existing paradigm, with skills that are optimized for the old technologies and customers who press for progress along established measures of performance.

These and many of other lessons developed through the research of innovation scholars can serve as powerful guidelines for leaders of industry as they guide their firms into new markets or help defend against emerging challengers. Most of the studies to date, however, have been based on research in the manufactured product industries, while relatively little has been done to understand technology and innovation in service industries.

"Services" is a tough nut to crack because it is an umbrella term for a variety of business activities that are heterogeneous in nature. A representative list of services that comprise a first-world economy might include restaurants, airlines, retailers, medicine, grooming, education, legal, banking, communications, and others. Such a list would encompass a diverse set of activities with different requirements for automation and, more importantly, different levels of experimentation and investment in innovation.

Researchers have attempted to break the service sector down into logical groupings to study patterns of innovation. Coombs and Miles suggest that services can be grouped by the level of client customization and the nature of its transformation processes as summarized in the table below (Coombs and Miles *in Metcalfe and Miles*, 2000). Interaction between the firm and its customers appear to be a common feature in the service sector. Coombs and Miles observe that the degree of customized interaction, however, can vary. They also observe that the nature of a service firm's core processes tends to fall into three categories – businesses that effect 1) physical transformations, 2) human transformations, and 3) information transformations.

Figure 1.1
Coombs and Miles Services Classification

CLASS OF TRANSFORMATION

		Physical Services	Human Services	Information Services
LEVEL OF CUSTOMIZATION	*Very High*	• Hotels • Domestic Service	• Surgery • Hairdressers • Counseling, Help and Advice Services	• Custom Software • Management Consultancy • Legal Services
	Moderate	• Traditional Restaurants • Laundry • Airlines • Retail & Wholesale Trade	• Mass Education • Welfare Services	• Insurance • Accountancy • Real Estate • Banking • Telematic Services • Telephone Services
	Low	• Fast Food Restaurants • Mass Public Transportation • Postal Services • Freight transportation		• Package Software • Broadcast Radio/TV

Adapted from Coombs and Miles, "Innovation, Measurement and Services: The New Problematique"

Regardless of whether or not it is accurate or complete, this view of the service sector is useful for an analysis of service innovation because it is provides a rudimentary glimpse into the different roles that technology might play in the core transformative processes. Coombs and Miles suggest that firms involved in physical services such as transport, repair, and domestic services have a clear need for mechanical systems. Meanwhile, human services typically involve service workers because they are highly tailored; technology that supports human interaction is therefore critical to this segment. Firms that are involved in information services rely heavily on technology for communication, amplification, and visualization. And businesses in all three categories are increasing their use of IT for back office functions. These observations point to an important

assumption with which most scholars seem to agree: that technology is ubiquitous and the focal point of innovation in service industries.

Product-based Services

There is a specific breed of service firms that is of special interest to my research. Scholars believe that the seamless integration of a product and a service is one of the keys to developing a product that will endure (Utterback *et al.*, 2006). The concept of integrating a product with a service is not a new idea. Telephones and payment cards, for example, have been around for many decades and have established the paradigm of a *product-based service* in markets around the world. Today, service companies continue to develop innovative new devices and/or platforms to deliver services to their customers, blurring the traditional line between products and services. Apple and its iPod is a clear example of this convergence; OnStar and its telematics service is another.

Would it follow, then, that the patterns of innovation for these product-based services are similar to those of product industries? Not exactly. My research suggests that there are some subtle but some important differences. Product-based service companies typically rely on external partnerships to supply component technology. Their contribution is in 1) the architectural integration of these components and 2) the services that are delivered over the resulting *technology delivery platform*. When a firm relies on a technology platform for delivering services, the platform itself can foster and accelerate the innovation process. For example, in the design of the iPod, Apple integrated component technologies supplied by five partners: Sony (battery), Wolfson (Codec and digital-to-analog converter), Toshiba (disk drive), Texas Instruments (FireWire technology), and Linear Technology (power management) into a specific vision for what an MP3 player should look like. The success of Apple's delivery platform has created a sizeable market for accessories fueled by demand for extending the use of the iPod (e.g., cameras, phones, FM receivers, gaming devices, etc).

While product-based service companies do not have to be R&D experts in component technology, designing the right platform does require 1) a "black box" understanding of the component functionality and 2) careful consideration of the emergent characteristics that any given component technology might contribute to the overall platform. We explore this idea in a detailed analysis of magnetic stripe and alternative payment identification technologies in Chapter 4.

Like product industries, managing knowledge assets is central to a service firm's ability to innovate. In particular, component and architectural know-how are important for platform development, while data-based know-how can greatly enhance the services that are provided. It is imperative, therefore, that managers responsible for product strategy be aware of established cultures and existing processes that might cause a firm to pass over this critical knowledge.

The initial motivation behind this thesis was to interpret established principles of innovation in the context of services-based industries. In proposing this topic, I assumed that certain aspects of product-based principles also describe patterns in service industries. My research revealed that some principles apply to both sectors. Others need to be extended. Still others apply selectively, depending on the nature of the service that is being examined. In the process of synthesizing the lessons learned from my literature review and the case studies I examined, Professor James Utterback pointed me to the convergence of product and services and the role of product platforms in this paradigm. What emerged was the idea of a technology delivery platform and throughout the latter parts of this thesis, I explore the different implications of this concept.

Thesis Structure

In Chapter 2, I begin by reflecting on several fundamental principles of discontinuous innovation and pointing out some explicit similarities between product industries and the payments industry. I also discuss a very important difference between product and service industries – that is the role technology plays in driving discontinuous change. This key difference between the two industries was the initial impetus for this study.

In Chapter 3, I revisit the classic distinction between product and process innovation. I present two case studies that show how technology is used in both cases. Using a case study of an "innovative" IT project in the sub-prime lending market as a backdrop, I present several general observations about process innovation in the payments industry. I also present two examples of product innovation: Apple's iPod and OnStar's telematics service. I argue that both businesses are service models that are characterized by a high level of dependence on technology for service delivery and introduce the idea of a technology delivery platform.

In Chapter 4, I develop the concept of technology delivery platforms. Technology platforms can simplify the development and delivery of new services, accelerating the time to market while keeping production costs low. To create an extensible platform that can be adapted to market changes, careful consideration must be given to the selection of the underlying component technology during the design process. I illustrate the nuances of this design decision by looking at magnetic stripe and alternative payment card technologies.

In Chapter 5, I extend the framework developed by Henderson and Clark and introduce the concept of component and architectural innovation in the context of a service organization. I suggest that incremental innovation results from advances in component refinements, while more significant innovation results from advances in architectural changes. Using these principles, I discuss the recent introduction of RFID technology in the payment card industry and suggest that the change will only be incremental (or sustaining) in nature.

In Chapter 6, I introduce the concept a knowledge asset and argue that two types of knowledge assets are the basis for architectural innovation; I highlight the difference between component and architectural know-how and show how these two types of knowledge assets were used in developing OnStar's delivery platform. I also note the potential of other knowledge assets such as data-based know-how and proprietary methods to help a firm create a significant competitive advantage.

Finally, in Chapter 7, I conclude by highlighting the key lessons learned in this study. I also discuss further work that can be done to validate some of the principles proposed.

Chapter 2
Products vs. Services: Apples and Oranges?

Joseph Schumpeter (1939) was one of the first to note that technological change could lead to waves of "creative destruction." In Schumpeter's earlier works, he observed the role of entrepreneurs in seizing discontinuous opportunities to innovate; later in his career, he placed greater emphasis on the role of large enterprises in innovation, pointing out that as scientific knowledge increased, only the larger firms had the wherewithal to effectively innovate. These observations, while valid to some extent, are incomplete in light of the thinking that has occurred since then. In fact, while large firms might have the resources to explore new technologies, they are disadvantaged when it comes to harnessing technological innovation (Leonard, 1995; Christensen, 1997).

Cooper and Schendel were among the first to observe that technology innovation is typically pioneered by a firm that is outside the industry. While sales of the old technology may continue to grow for a period of time, the new technology matures according to the shape of an S-curve and eventually surpasses sales of the old.

While insightful, these observations are largely based on analyses of manufactured-product industries. Little has been done to study the impact of innovation on service industries. In Mastering the Dynamics of Innovation, James Utterback presents five basic tenets of modern innovation theory using the evolution of the typewriter to illustrate principles that are at play when firms in an industry innovate:

- New innovations leverage existing capabilities
- Emergence of a Dominant Design
- Shift in the landscape of the market
- Waves of technological change
- Changing leadership at breakpoints in technology

While these principles were also based on studies of product industries, Utterback's observations seem to be relevant to the financial services industry as well.

New innovations leverage existing capabilities

Utterback observes that innovations are typically a synthesis of existing technologies. The early typewriter joined together existing mechanical technologies while the early electric typewriter joined familiar components such as electric motors and the QWERTY keyboard; later, the personal computer combined the same QWERTY keyboard, the established typing conventions, and components from other industries such as television monitors, printed-circuit boards, memory chips, and semiconductors.

Like manufactured products, service innovations are also a synthesis of existing capabilities – both concepts and technologies. The history and evolution of the credit card illustrates this point. The credit card can be decomposed into two basic components or concepts: the underlying business product, a line of credit, and the technology (e.g., magnetic stripe card) that enables the delivery of the service.

> *Lines of credit.* As a general practice, lending can be traced back to biblical times. Merchants have been extending credit to their best customers for centuries, providing goods in advance of actual payment. In 1730, a furniture merchant named Christopher Thompson advertised furniture that could be paid off weekly[1], one of the earliest documented financing offers. In 1910, Sears began offering lines of credit to its wealthiest patrons – those of "unquestionable responsibility" – in response to customer requests. In short, lines of credit were already available in many different forms by the time the credit card was born.

> *Payment Cards.* Payment mechanisms have been around since at least the early twentieth century. In 1914, Western Union gave some of best customers a metal card to be used for deferring payments – interest free – on services used. Several large department stores began to follow suit, allowing their best customers to pay off their purchases in regular installments. Charge plates with customer embossed information were issued by department stores in 1928.

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[1] http://www.thehistoryof.net/history-of-credit-cards.html

While merchant-specific payment "cards" continued to grow in popularity, a general use credit card that could be used at multiple merchant locations did not emerge until 1949. The legendary story of how it all started (or at least an embellished version of it) can be found on the Diners Club website:[2]

> In 1949, Frank McNamara schedules a business meal at a New York restaurant called Major's Cabin Grill. Prior to dinner, he changes suits. After dinner, the waiter presents the bill. Frank reaches for his wallet...and realizes that he has left it in his other suit. McNamara finesses the situation, but that night he has a thought, "Why should people be limited to spending what they are carrying in cash, instead of being able to spend what they can afford?" In February 1950, McNamara and his partner, Ralph Schneider, return to Major's Cabin Grill and order dinner. When the bill came, McNamara presents a small, cardboard card – a Diners Club Card – and signs for the purchase. In the credit card industry, this event is still known as the First Supper[3].

McNamara and his partner Ralph Schneider started with $1.5 million in capital and signed up fourteen New York City restaurants, giving away cards to selected people. By the card's first year anniversary, the install base of cardholders had grown to 42,000 and the merchant network to 330 restaurants, hotels, and nightclubs.

McNamara's idea, while innovative, was not radical with respect to many of the underlying concepts and technology. The president of a New York credit company, McNamara was well-versed in the business of lending. And by the 1950s, issuing charge plates was a well-established practice by oil companies, hotels, and department stores. The Diners' Club concept was in fact an extension of existing capabilities. McNamara does deserve credit for packaging existing capabilities and adding *ancillary* features (i.e., an extended merchant acceptance network).

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[2] A Newsweek article in 1951 reported McNamara having lunch and made the embarrassing discovery while drinking coffee.

[3] http://www.dinersclubnewsroom.com/anniversary.cfm

Dominant design

Utterback observes that product innovation activity typically culminates when a dominant design emerges. During the early stage of an industry, no dominant design exists. Users have not made up their mind about a preferred product design, and companies are experimenting. Eventually, the characteristics of the different products in the market tend to converge, and a dominant design begins to emerge. The QWERTY keyboard is an example of an enduring dominant design. The configuration of the keys on the QWERTY keyboard was arranged to minimize the jamming of the type bars that occurred. Keys were arranged so that frequently struck letters were placed on opposite sides of the machine. But despite innovations in typing technology (e.g., daisy wheels and the digital devices which eliminate mechanical typesetting altogether) and the emergence of more ergonomically efficient keyboards such as the Dvorak keyboard, the QWERTY keyboard remains the universal standard.

The legend of McNamara aside, there was no single event that triggered the credit card revolution. Around the same time McNamara had his epiphany at a NYC restaurant, a number of banks were already busy marketing a product that would be a predecessor to the credit card. In the late 1940s, several US banks were giving their customers specially-issued paper that could be used like cash in local stores. The underlying concept was very similar to that of a credit card: banks extended credit to their customers through the paper vouchers which could be used within a network of merchants who honored them.

The charge plates that were issued by retail firms, paper vouchers, and McNamara's cardboard card were all mechanisms that were used to deliver a similar service (i.e., a line of credit). Properties of the different mechanisms eventually converged as both banks and retailers began to embrace the imprint card as the dominant design. In 1951, the Franklin National Bank in New York formalized the practice by rolling out a credit card using imprint technology to replace paper coupons and soon 100 other banks began to issue cards as well.

Shift in the landscape of the market

Remington and two or three other vendors comprised the early typewriter market. Later, an explosion of competing firms occurred, followed eventually by an implosion of firms as the industry consolidates. This implosion is typically tied closely to the emergence of a dominant design.

By the 1930s, retailers were no longer extending credit exclusively to the wealthy. Credit strategies continued to evolve as retailers began to charge interest and introduce interest-free grace periods into their programs. The first general purpose credit cards were launched in the 1950s and picked up momentum through the 1960s. The base of cardholders and acceptance locations grew and financial institutions began to encroach on the domain of the retailers. This development was met with strong resistance, as retailers refused to accept general purpose cards. Many of the large retailers in particular wanted to maintain control over their own receivables and believed that if they were to abandon their programs, they would ultimately lose control of the customer relationship.

Over time, general purpose bank cards began to win the battle as the value proposition for both the consumer and the retailer proved to be compelling. For the customer, the general purpose card could be used at multiple locations whereas the private label card was merchant specific. For the merchant, not accepting a general purpose card often meant the loss of a sale if a customer was not able to spend beyond what he/she had in cash. In addition, retailers learned over time that their core competency did not lie in consumer lending. A decline in overall credit quality over the past two decades has resulted in an increase in credit card chargeoffs from 2% in 1985 to nearly 5% today. Experienced in the lending business, banks managed these risks by raising interest rates on revolving balances and lowering credit limits. Retailers, however, were not able to keep up and private label credit card programs became liabilities as their portfolios fell into the red.

Figure 2.1
General Purpose Bank Card vs. Private Label Chargeoff Rates

Chargeoff Rates for Bank Cards vs. Private Label Credit Cards in the US (2000–02)

Private label chargeoffs continue to grow and maintain gap vs. general purpose cards

(% Chargeoffs)

(1) Adjusted for cash back advances.

Exhibit # 41:34C-E1
Source: TowerGroup
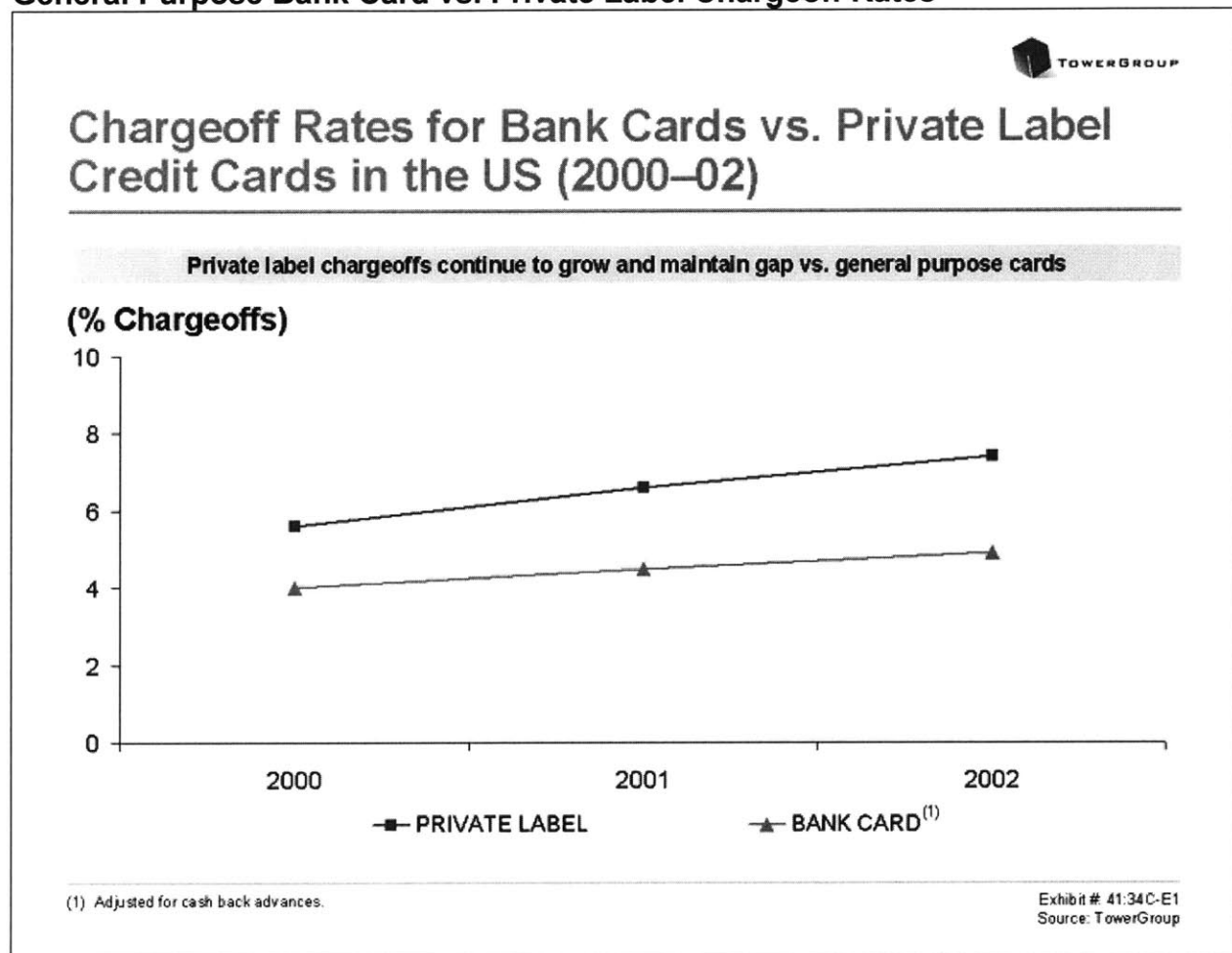
Source: TowerGroup

As a result, the number of retailers that issued private-label cards in-house continued to decrease. In recent years, continued competition from general purpose cards, an increase in the volume of bad loans, margin pressures, and other factors have forced even the largest in-house issuers to outsource or sell their card businesses outright.

Technology S curves - Waves of technological change

The shift from the mechanical to the electric typewriter and later the personal computer represented over a century of technical evolution centered on putting words on paper neatly and efficiently. Each wave of change was based on a different technology, requiring different competencies on the part of the producing firms.

The payments industry followed the same general trend. By the early '70s, two decades after the inception of credit cards, less than 20% of US households had one or more card(s); credit card charges as a percentage of household income was at a meager 4%. By the late '80s, nearly 60% of all households had one or more cards, and charges as a percentage of household income grew to over 10%. Technological change played a critical role in adoption of the general purpose credit card. The introduction of charge plates was a significant technological innovation for the payments industry as they streamlined retail credit operations and paved the way for mass commercialization. With the customer's name, address, and credit information stamped on a metal tag, retailers could capture transaction information by placing the plate along with a sales slip into an imprinter or recorder.

Adoption was further accelerated by the introduction of magnetic stripe technology. Magnetic stripe cards were first implemented in the early 1960s by the London Transit Authority for automated fare collection. By the late 1960s, the Bay Area Rapid Transit in the U.S. implemented a system that used a paper-based magnetic stripe ticket which was read and written to every time the card was used. It wasn't until the establishment of standards in 1970 that the magnetic stripe technology began to transform the way payment transactions were handled.

The magnetic stripe card is really a series of tiny iron-based magnetic particles mounted on a plastic-like film. Each particle is a thin bar magnet about 20 millionths of an inch long. The magnetic stripe can be written to because the bar magnets can be polarized. Bar magnets are equivalent to "bits" in computer terms as they both communicate information through 0's and 1's. The card reader technology can be likened to a tape cassette player, but instead of a motor moving the film through the read, the swipe motion allows information to be captured by the terminal.

Today, credit cards follow the ANSI/ISO 7811/1-5 standard to ensure readability worldwide. The standard specifies properties of the plastic card itself, characteristics of the magnetic stripe, and the location of the embossed characters. There are three

tracks on the magnetic stripe of a credit card, each about one-tenth of an inch wide. The tracks contain much of the information that is required to initiate a payment transaction including cardholder name, primary account number, expiration date, country code, etc. Convenience and ease of use give credit cards their universal appeal. The introduction of standards for the magnetic stripe in the 1970s simplified information capture and lead to the rapid adoption of payment cards in the '80s.

Changing leadership at breakpoints in technology

In the product industry, when new waves of technology emerge, newcomers from outside typically assume leadership of the market while incumbents of the old paradigm fall to the wayside. Disruptive technologies often come from unexpected places as in the case of the typewriter market when an outsider named IBM invaded. When this happens, incumbents typically react in a way that while managerially appropriate, causes them to lose their leadership position in the market.

Despite the similarities between product and services industries, this principle is perhaps the biggest difference between the two. As both Utterback and Christensen's research suggest, technology breakpoints often shift the landscape of firms within an industry for product industries, but this phenomenon is not as common in the banking industry. The recent introduction of RFID, for example, represents a breakpoint from the established magnetic stripe technology, yet as we will discuss in Chapter 5, this breakpoint has not shifted the landscape of general purpose credit card issuers.

Technology and Innovation

Scholars have analyzed individual firms and entire industries to identify patterns of innovation and many of the resulting studies suggest that technology is in fact an important factor. Utterback (Mastering the Dynamics of Innovation, 1996) and Christensen (The Innovator's Dilemma, 1994) both explore the potentially disruptive or discontinuous nature of technology and present numerous accounts of industries that have been radically restructured as a result of an invading technology.

In The Innovator's Dilemma, Christensen makes mention of several service industries and claims that technology innovation was a disruptive force. In one of his examples, Christensen observes that Sears Roebuck was heralded as one of the best-managed retailers in the world for decades, but today, it is a struggling company looking to reinvent itself – a "disappointment for investors" according to Forbes.[4] Christensen suggests that Sears' failure can be attributed to its management missing the advent of discount retailing and home centers, which usurped its core retailing franchise. At the same time, MasterCard and Visa usurped the sizeable lead that Sears had in the payment card business. Christensen claims that disruptive changes in technology played a key role in Sears' failure on both fronts.

This explanation for Sears' fall from preeminence is somewhat counterintuitive due to the way Christensen confuses the distinction between a technology disruption and business model disruption. It was in fact new business paradigms (i.e., discount/catalog retailing and general purpose credit cards) that disrupted the incumbent models. It is worth noting, however, that technology does, play an important role on a tactical level.

Christensen cites several other service industry examples in which technology does not appear to be the primary reason for the disruption. He claims that nurse practitioners (NPs) disrupted medical doctors. Historically, nurses assisted physicians in providing medical care. Today, NPs can provide many of the same medical care services that a physician can, including the prescribing of medication, and, in some states, psychiatric counseling. In many states, NPs are required to practice in collaboration with physicians, but generally speaking, they work autonomously and some are able to open their own clinical practices. In this example, technology is not the cause of the disruption; a new business paradigm, influenced by changing regulatory constraints, caused the disruption.

Christensen also suggests that decisions based on credit scoring models disrupted the personal judgment of banking lending officers. In this lending example, technology did

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4 Weiner, Steve, "It's Not Over Until It's Over," Forbes, May 28, 1990

play a role in automating credit decisions, but it was the underlying credit scoring models, a knowledge-asset that enabled companies to systematize the evaluation of creditworthiness, that triggered the disruption. Again, information technology plays an important role in the actualization and deployment of the knowledge asset, but the availability of the underlying technology itself was not the disruptive force.

In his first book, Christensen uses an unconventional definition of technology to reconcile these ambiguities. He states that technology represents "the processes by which an organization transforms labor, capital, materials, and information into products and services."[5] Later in his second book The Innovator's Solution, he clarifies this difference by introducing the concept of a disruptive business model. These examples of service-based industries suggest that the disruptive potential of technology for services industries might be different.

[5] Christensen, 1997

Chapter 3
The Role of Technology in Services

Technology plays an important role in service firms. In fact, research has shown that service firms are among the most active user of technology in the world, especially of information technology (Miles *et al.*, 1990). From the enablement of business intelligence, to operational process automation, to service delivery, to financial accounting, service firms use technology in many ways – too many ways to enumerate. It would therefore be a useful starting point for this paper to establish a high-level framework for understanding the role of technology in services.

In the service domain, technology usage can be grouped into two distinct categories: product- vs. process-related activities. That process innovation can be analytically separated from process innovation in service industries is not a new idea (Preissl, B, 1997). However, the distinction between product and process might not be as clear in services as it is in manufactured products. In this chapter, we revisit the current thinking on product and process innovation from the manufacturing industry and present two case studies to show how technology assumes similar roles in service industries.

Product vs. Process Innovation

Utterback and Abernathy observe that there is a difference between product and process innovation. Product innovation has to do with the evolution of the physical form of the invention. Process innovation has to do with the manufacturing methods and/or technologies that enable firms to produce large quantities of the product in a cost effective manner.

For manufactured products, Utterback and Abernathy suggest that innovation generally occurs in three distinct phases:

- In the fluid phase, the aggregate level of product innovation for assembled products is high, but the level of process innovation is low. Utterback's

description of this first phase of activity provides an insightful picture into the difference between product and process innovation:

"...a pioneering firm gets the ball rolling with its initial product, a growing market begins to take shape around that product, and new competitors are inspired to enter and either expand the market further or take a chunk of it with their own product versions. At this embryonic stage, no firm has a 'lock' on the market. No one's product is really perfected. No single firm has mastered the processes of manufacturing, or achieved unassailable control of the distribution channels. Customers have not yet developed their own sense of the ideal product design or what they want in terms of features or functions...This environment is conducive to market entry by many firms as long as capital and technical barriers are not too high..."[6]

- In the transitional phase, product innovation begins to decrease, conforming to a dominant design that has emerged, and process innovation begins to pick up as cost becomes a bigger factor in buying decisions.

- Finally, in the specific phase, both product and process innovation levels are relatively low; many firms have exited the market as products have become a commodity.

Like manufactured product industries, there also appears to be a difference between product and process innovation in the payments industry. There is, however, a distinction between the "product" – that is the options and features of a service – and the "process" by which the service is delivered.

Technology as a Process Enabler

Information technology (IT) is a key enabler and a central focal point of much of the innovation that occurs in the banking industry. Francis Frei *et al.* (1999) characterize a

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[6] Utterback, 1994

bank, like any organization, as "a bundle of production or service delivery processes." One very common application of IT is to automate otherwise paper-based, manual, and error prone processes. Frei *et al.* suggest that efficiency is not the only benefit that banks (or other service organizations) might gain from automation. Their research shows that process consistency, particular those that impact the customers' experience, has a positive correlation to business performance and profitability. Technology can play a key role in reducing process variation.

What follows is a case study detailing a specific innovation project in the sub-prime credit card market. Though the case study focuses on a specific activity in a niche market, it alludes to many themes that are representative of process innovation efforts in the payments industry.

Case Study: CompuCredit

Sub-prime lending describes the practice of extending credit to customers with limited or blemished credit histories from previous payment delinquencies, lender charge-offs, or bankruptcies. Typically characterized by a FICO credit score of less than 620 (FICO credit scores range from 300 to 850), sub-prime customers are often perceived by banks as having a reduced ability for repayment as measured by their credit score, debt-to-income ratio, or other criteria. Sub-prime lenders typically charge customers a higher interest rate to compensate for the increased risk of default.

Needless to say, sub-prime lending is risky business, and managing the risk effectively is the key to success. In recent years, many sub-prime lenders have gone bankrupt or have stopped making loans to this segment. The prevailing cause for their general exodus is increased rates of default from the loans that were originated. CompuCredit, however, continues to grow profitably in this niche.

Background
Founded in 1996 and based in Atlanta, Georgia, CompuCredit Corporation provides consumer credit and related products to the "under-banked" market (e.g., sub-prime and

unbanked) with five primary products: credit cards, investments in previously charged-off receivables, retail micro-loans, automobile finance, and stored-value debit cards. One of the keys to CompuCredit's success is their proprietary credit scoring models, which enables it to target profitable customers in segments that are perceived by traditional retail lenders as high risk.

CompuCredit's largest line-of-business is unsecured credit cards. Considered a Top 15 general purpose credit card issuer in the U.S., CompuCredit markets unsecured general-purpose Visa, MasterCard, and Discover charge cards through contractual relationships with other third-party institutions. Under these agreements, the partner institution technically issues and owns the credit card accounts, while CompuCredit purchases the underlying receivables. This business model creates operational complexity for CompuCredit because it partners with numerous issuers and many of them issue multiple card products (or "portfolios") under the CompuCredit contract.

From an underwriting perspective, CompuCredit assumes all responsibility for targeting prospective customers, assessing their credit risk, and soliciting them through mail campaigns. CompuCredit also services all the cards it underwrites so in addition to their ability to successfully predict the performance of these accounts, managing the day-to-day transaction risks associated with this market is critical to the success of the sub-prime business. To this end, fraud and dispute management operations are an important facet of the business.

Dispute Management Before Automation

Dispute management is a labor intensive and costly process within the credit card servicing function. CompuCredit's dispute management process was paper-intensive and revolved around manual data-entry and human decision-making.

> ***Manual re-keying of data.*** Upon receipt, bundles of paper-based dispute forms were distributed to clerks who keyed the individual claims into one of two processing systems (FDR or TSYS) depending on the card portfolio to which the

account belongs. The paper-claims were then placed into a queue (i.e., a file drawer) to be reviewed by analysts on a first-in-first-out basis.

Disparate systems. Because of the complexities of navigating the FDR and TSYS systems, analysts were typically trained in one environment or the other. After reviewing the claim, an analyst uses FDR or TSYS to capture the reason code, generate a correspondence acknowledging the claim, and initiate any other system activities related to the claim.

Paper-based processes. The analyst may approve or deny a chargeback after an initial review. If however, additional information is required (e.g., missing information from the cardholder, a sales draft from the merchant, etc.), the analyst creates a paper-based cover page summarizing the claim and files all the paperwork into his/her file drawer to be reviewed at a later date. If a chargeback is initiated, a clerk makes copies of the required paper work and forwards it to Visa/MasterCard.

Inability to report. Analysts were required to log all their case work into a Microsoft Excel-based productivity worksheet (one per analyst). Without a centralized repository for analyst activity, it was extremely difficult for managers to produce regulatory and portfolio audit reports when they were needed.

Inability to prioritize and manage disputes strategically. Lack of activity and information transparency due to paper-based makeshift processes prevented management from being able to implement continuous improvement initiatives. Regardless of the dollar value, reason code, chargeback history of the cardholder, etc., all disputes were handled on a first-in-first-out basis.

Figure 3.1
CompuCredit Paper-based Dispute Processing Operation

As CompuCredit's card portfolio grew, management was concerned that the dispute management function would not be able to scale efficiently and consistently. CompuCredit turned to Business Process Management (BPM) software to address their operational deficiencies. BPM is typically an umbrella term used to refer to activities performed by organizations to manage and, if necessary, to improve their business processes. According to Wikipedia:

> Business process management is a field of knowledge at the intersection between Management and Information technology, encompassing methods, techniques and tools to design, enact, control, and analyze operational business processes involving humans, organizations, applications, documents and other

sources of information. The term 'operational business processes' refers to repetitive business processes performed by organizations in the context of their day-to-day operations, as opposed to strategic decision-making processes which are performed by the top-level management of an organization. BPM differs from business process reengineering, a management approach popular in the 1990s, in that it does not aim at one-off revolutionary changes to business processes, but at their continuous evolution. In addition, BPM usually combines management methods with information technology[7].

BPM software enables organizations to design, execute, and automate business processes. In addition, BPM software monitors the execution of the business processes so that managers can analyze and modify processes in response to operational data.
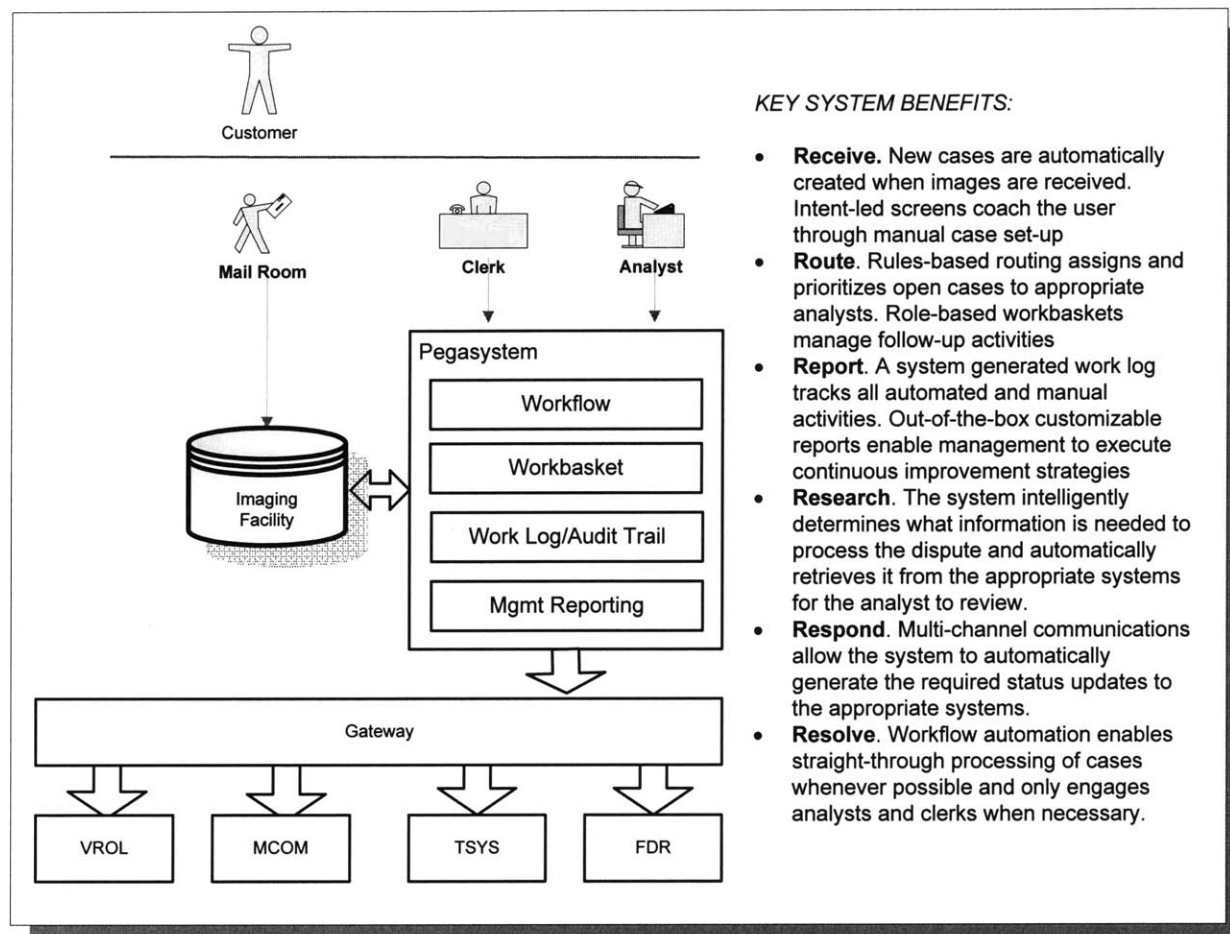
Dispute Management After BPM

CompuCredit developed a solution with BPM software that automates many of the tasks associated with dispute processing and guides staff through tasks that require human intervention.

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[7] www.wikipedia.org

Figure 3.2
CompuCredit BPM-based Dispute Processing Operation

KEY SYSTEM BENEFITS:

- **Receive.** New cases are automatically created when images are received. Intent-led screens coach the user through manual case set-up
- **Route.** Rules-based routing assigns and prioritizes open cases to appropriate analysts. Role-based workbaskets manage follow-up activities
- **Report.** A system generated work log tracks all automated and manual activities. Out-of-the-box customizable reports enable management to execute continuous improvement strategies
- **Research.** The system intelligently determines what information is needed to process the dispute and automatically retrieves it from the appropriate systems for the analyst to review.
- **Respond.** Multi-channel communications allow the system to automatically generate the required status updates to the appropriate systems.
- **Resolve.** Workflow automation enables straight-through processing of cases whenever possible and only engages analysts and clerks when necessary.

Using BPM software along with a third-party imaging solution, CompuCredit shifted the entire dispute management process to an electronic environment.

Automated task assignment. Dispute forms are scanned and automatically routed to the appropriate clerk/analyst for processing. Open cases are queued in role-based work baskets and follow-up activities are automatically re-queued.

Paperless environment eliminates errors. Rules-based process management capabilities enforce process and data consistency, helping reduce manual errors such as keystroke mistakes, omissions (e.g., forgetting to update the case cover sheet), misfiling, etc.

Centralized platform increases versatility. Through an extensive suite of integration services, the BPM solution serves as the central hub for external system interfaces including FDR and TSYS. Not only are clerical keystrokes for operating the FDR and TSYS systems minimized, CompuCredit is also able to do away with system-specific personnel, enabling it to maximize utilization of existing staff.

Reporting and compliance. The BPM solution also greatly reduces the time required to generate reports. In the old paper-based process, generating an aged or audit report required over 10 hours of effort – assembling the Excel-based ticker sheets for each analyst, consolidating system reports from FDR/TSYS, etc. Today the effort requires 2 minutes using the solution's fully integrated auditing environment. The built-in audit trail also facilitates supervision and review of individual case investigations quality control, continuous improvement, re-presentment, and other follow up activities.

Scalability and Future Growth for CompuCredit

Using BPM to facilitate business process outsourcing, CompuCredit was able to reduce monthly operational staff costs by 50%. While the majority of the staff was outsourced, total headcount in the dispute management function stayed the same. Within one month, the new outsourced staff was processing volumes that were comparable to the previous, more experienced staff. CompuCredit's management expected that over time, investigators would be able to take on even more volume as they become more proficient in their roles. Less than one year after the initial rollout of the BPM solution, CompuCredit has grown its account base by 50% (active accounts have increased by 20%); meanwhile, the offshore dispute management staff has been able to support this growth without increasing headcount. That new staff can be trained in 2-3 days (vs. 2-3 weeks in the old environment) and process substantial case volumes within one month is critical to CompuCredit's growth plans.

Technology as a Product Platform

The Apple iPod has taken the MP3 market by storm, capturing more than 70% of the MP3 player market by 2004. It was not the first of its kind, but it revolutionized the industry through innovative design elements (Utterback *et al.*, 2006). One of the iPod's central design concepts is the seamless integration of a physical hardware product and a service offering. Released in 2001, the iPod was designed to be a pocket size audio player built designed around an elegant scroll wheel user interface. Most iPod models store media on built-in memory and all are able to connect to the iTunes website where content delivery services are provided for a fee.

OnStar is another business that, like the Apple iPod, falls into a category that is characterized by a high level of dependence on technology for service delivery. All of OnStar's services are innately tied to the architecture of a manufactured product (i.e., an automobile). The following case study provides an overview of OnStar's business and its innovative technology platform.

Case Study: OnStar

Founded in 1908, General Motors Corporation (GM) is the world's largest automaker. Headquartered in Detroit, GM manufactures cars in trucks in over 33 countries and sells under numerous brands including Buick, Cadillac, Chevrolet, GMC, GM Daewoo, Holden, HUMMER, Opel, Pontiac, Saab, Saturn and Vauxhall. OnStar, a wholly-owned subsidiary of General Motors, provides in-vehicle safety, security and communications services for GM vehicles in the U.S. and Canada. Today, the OnStar service is an optional feature, but by the end of 2007, OnStar will become standard on nearly all GM retail vehicles.

OnStar was founded in 1995 as a collaborative effort between GM, EDS and Hughes Electronics Corporation. Each company brought a specific set of knowledge assets to the initiative: GM brought vehicle design and integration expertise as well as a fleet of vehicles that were established in markets around the world; EDS brought expertise in systems development, information management and customer service technologies;

and Hughes excelled in communications, satellite technology, and vehicle electronics. OnStar was officially launched in 1996 at the Chicago Auto Show. Its first product was delivered for the Cadillac DeVille, Seville and Eldorado models. Today, OnStar offers a variety of safety, security and communications services to subscribers. Integrated cellular voice technology allows subscribers to make hands-free calls and access a number of "concierge" services provided by OnStar advisors. More sophisticated diagnostic technology enables OnStar to provide vehicle monitoring services. Collision detection systems allow OnStar to deploy roadside assistance or emergency services when needed. A summary of OnStar's services is presented in the table below.

Figure 3.3
Summary of OnStar Services

OnStar Feature	Description	Total Usage to Date
OnStar Vehicle Diagnostics	Automatic monthly vehicle diagnostics checks and complimentary email reports	15.5 million diagnostic emails
OnStar Turn-by-Turn Navigation	Voice guided direction to help lead the driver to destination	17 million calls for directions
Automatic Notification of Airbag Deployment	If airbags deploy, Onstar will attempt to contact registered user to offer assistance	50,000 automatic collision responses
Emergency Services	Request emergency assistance in life threatening situations	620,000 emergency calls handled
Stolen Vehicle Location Assistance	If vehicle is stolen, OnStar can help authorities locate it	24,000 stolen vehicles located
Remote Door Unlock	OnStar advisor can send a signal to unlock doors if locked out	1.9 million doors unlocked
Access to Hands Free Calling	Push of one button enables voice activated calling, allowing driver to keep eyes on the road	1 billion hands-free calling minutes
Roadside Assistance	OnStar can contact nearby service providers if the customer is in need of roadside assistance	1.1 million roadside requests

Accident Assist	OnStar provide step-by-step guidance about what to do in the event of an accident	N/A
Remote Horn and Lights	OnStar can activate a car's horn and lights to enable drivers to locate their car	N/A
Virtual Advisor	OnStar Advisor provides local traffic, weather and stock quotes	N/A
Driving Directions	Live OnStar Advisor provides directions to any destination	N/A
RideAssist	OnStar will call a taxicab in the event a customer is unable to drive	N/A
Information Convenience/ Services	OnStar Advisor provides restaurant recommendations, hotel locations, and other information services	N/A

Source: *www.onstar.com*

OnStar's services are delivered primarily through specially designed onboard systems in conjunction with cellular and satellite technologies. In a typical interaction, a customer initiates a connection to the customer service center by pressing the blue OnStar button that is built into a vehicle. The service center receives the call for service along with information on the location of the vehicle. Built-in devices enable voice-to-voice communications and allow the call center advisor to deliver the requested services live.

OnStar combines four distinct technologies to enable the delivery of its services: cellular communications, global positioning technology, and vehicle diagnostic and monitoring technologies. The joining of the four technologies has given birth to a new technology called telematics – that is, technology that facilitates the transmission of data communications between systems and devices to enable in-vehicle safety, security, and information services.

Global positioning systems work by using satellites to process a radio signal that originates from a vehicle. The distance of the vehicle from the satellite can be

calculated by measuring how long it takes a radio signal to reach the satellite. Four separate satellites are used to calibrate the location of a vehicle. In some vehicles, the wheel speed and direction are also used to further enhance the calibration. OnStar uses the NAVSTAR GPS system which consists of 24 satellites that orbit the earth at an altitude of 10,900 nautical miles with a 12 hour orbital period.

Impact Detection Technology. OnStar equipped vehicles also contain a series a sensors that are used for collision detection. Front and side sensors are capable of detecting external impact and works with the Sensing and Diagnostic Module (SDM) to determine crash severity. When a moderate to severe frontal or side-impact crash occurs, data is transmitted from the sensor(s) to the SDM. The SDM sensor itself can also detect a rear impact of sufficient severity. The SDM then transmits the crash information to the vehicle's OnStar module.

Figure 3.4
OnStar Vehicle System Architecture
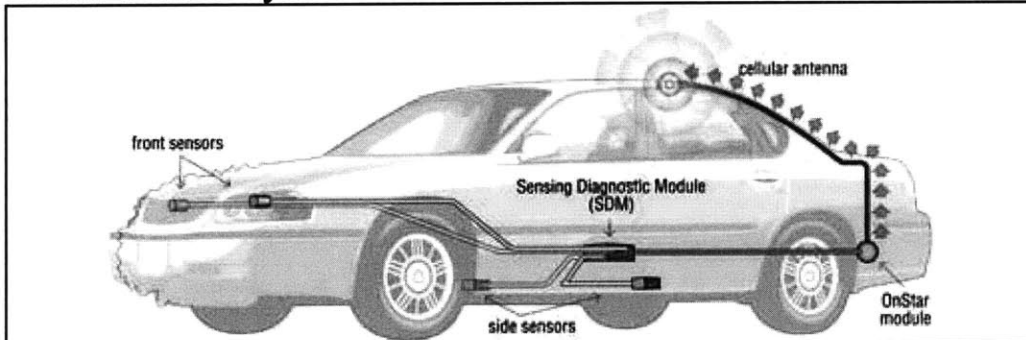
Source: www.onstar.com

The OnStar module sends a message to the OnStar call center through the cellular connection, informing an advisor of the accident. A voice connection between the advisor and the vehicle is established and if necessary, the advisor can conference in 911 dispatch. If there is no response from the occupants, the OnStar advisor can provide the emergency dispatcher with information about the crash retrieved from the SDM; the dispatcher can then determine which emergency services may be appropriate. The onboard GPS system enables OnStar to provide the location of the accident.

OnStar's self-diagnostic technology communicates with the vehicle's major subsystems to diagnose more than 400 malfunctions that might involve the vehicle's engine and power train systems, the antilock brake system and/or the air bag system. The system can identify numerous issues ranging from transmission fluid temperature to engine misfire, fuel injector malfunction to an overheated engine. The malfunctions recognized by the OnStar's self-diagnostic technologies represent more than half of all service and repair incidents that a customer typically encounters.

The self-diagnostic technology is the basis for several OnStar services. Automatic vehicle diagnostics checks the vehicle's major subsystems monthly and sends email reports to the subscriber. When the vehicle is on the move, the self-diagnostic technology triggers a warning light on the car's instrument panel if there is an issue. A subscriber would then connect with an advisor at the OnStar call center, who provides insight on the warning light that was flashing and instructions on what the driver ought to do next. If the subscriber feels that more information is necessary, the OnStar advisor can send a coded signal to the vehicle that checks the status of the functions that are associated with the warning light that was activated. The advisor might also check functions that do not have a warning light.

General Observations

Service industries have long been regarded as laggards with respect to innovation but studies on services beginning in the early 1980s have changed some of this perception. Essays compiled by Metcalfe and Miles suggest that innovation in service industries tend occur around technology (Metcalfe and Miles, 2000). Indeed, one might observe that service industries with relatively low levels of dependence on technology such as the legal profession, for example are rarely cited for groundbreaking innovations.

Service firms often acquire their technology from third-parties and customize it for their specific organizational and business requirements (Metcalfe and Miles, 2000; Antonelli, 1988). All of the examples we discussed in this chapter exhibit this pattern of

innovation. In the banking industry, a vast industry of software application vendors offering solutions that address core product accounting (customer deposits, mortgages, etc), customer call center management, campaign management, risk management, and many other functions continues to thrive for this very reason. CompuCredit turned to a business process management software vendor for a dispute management solution. Apple partnered with Sony, Wolfson, Toshiba, Texas Instruments, and Linear Technology to develop the component technologies needed for the iPod. OnStar relied on its partners to supply the knowledge on the individual component technologies needed to build the delivery platform.

Product-based services are fascinating in that they represent the convergence of the product and service domains. Product-based services are characterized by 1) a technology device that a customer purchases (or possesses, as in the case of a credit card), 2) services that are provided to the end-user through the device, and 3) an underlying technology infrastructure that interfaces with the end-user device to deliver the services. In the next chapter, we take a closer look at the technology delivery platforms that are so important to this type of service model.

Chapter 4:
The Convergence of Service and Product

In the previous chapter, I discussed the role of technology in service delivery. Apple's iTunes and OnStar's in-vehicle security, communications, and diagnostics system are examples of services that have been seamlessly integrated into hardware devices. There are in fact other examples of everyday services that are inseparable from the "products" that enable their delivery. For example, in wireless telephony, the product (a mobile handset) cannot be separated from the voice or data service. One might argue that Internet connectivity services have been on a collision course with personal computers.

Technology as a Service Delivery Platform

When a physical product plays such a critical role in service delivery, it is useful to think about the underlying technology as a platform. In <u>The Power of Product Platforms</u>, Meyer and Lehnerd describe the innovative design strategy of Black & Decker that enabled it to reinvent the company and dominate the market for years. As a member of the management team, Lehnerd had decided to redesign the company's entire line of consumer power tools – all at once. His design focused on the development of common set of connections that each member of the product family shared. The electric motor, housings, gearing, switches, etc. were all redesigned so that common components could be extended to serve in multiple products. The redesign gave birth to a product platform that enabled Black & Decker to reduce labor costs by 85 percent and materials costs by 40 to 85 percent. Moreover, the reusable common components served as a springboard for new products, accelerating the time to market while keeping production costs low. For a number of years, the rate of product introductions averaged one per week[8] because the focus of innovation efforts was reduced from designing complex devices in their entirety to integrating modular subsystems and perfecting the incremental attachments.

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[8] Meyer and Lehnerd, 1997

In the same way that Black & Decker's product platform greatly simplified new product development, OnStar's technology platform has also simplified the development and delivery of new services. OnStar holds service patents for traffic update and rerouting information, location specific fuel emissions compliance for a mobile vehicle, remote vehicle diagnostic monitoring, and others – all delivered over the firm's integrated technology platform. In addition to subscription-based services, OnStar's technology platform also enables it to provide critical information to government agencies and emergency services. When a serious accident occurs, for example, and the driver is unconscious, the onboard sensing diagnostic module is able to capture valuable information about the direction and intensity of the impact, allowing doctors and surgeons to provide immediate attention where it is needed.

Likewise, Apple's core iPod/iTunes technology platform has spawned many add-on innovations by Apple itself as well as a growing number of aftermarket vendors. Accessories enable the iPod player to receive FM transmissions, serve as a gaming device, function as a camera or a phone, and many other clever extensions of the product. Utterback *et al.* (2006) noted that one of the newest content services provided on the iPod, the Podcast, was created by a user community that took advantage of Apple's use of open standards in its technology platform.

Creating the Right Platform

Component technologies or subsystems can contribute unique characteristics to the larger system. Therefore, careful consideration must be given to the selection of the underlying technologies during the design process. Scholars have noted that the selection of a specific technology generally constrains the firm to specific capabilities. Dosi[9] interprets this phenomenon as a *technology paradigm*, which he defines as the application of a selected technology to a specific problem. Once a solution is sought in the context of a specific technology, it is constrained to "selected principles derived from natural sciences and on selected material technologies." A technology trajectory

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[9] Dosi, Giovanni, 1982, "Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change," Research Policy 11, 3, 147-162

measures the progress in creating a solution for the problem via the selected technology paradigm and offers "strong prescriptions for the directions of technical change to pursue and those to neglect."

Let us return to the payments industry and look at how different technologies feature different capabilities. Magnetic stripe technology has served as the de facto enabler in the payment card business for years, facilitating data transfer at the point-of-sale. But there are a number of alternative identification technologies around which the industry could have built its infrastructure platform, each having its own set of strengths and weaknesses.

Payment Card Identification Technology

Magnetic stripe cards have been the standard in the U.S. payments industry for nearly three decades. Payment data transfer was paper-based until the late1970s. Merchants relied on imprint machines to capture a cardholder's name and account number. In addition to lengthy transaction times at the point-of-sale, paper-based transactions were error-prone. As merchants turned their receipts into their bank for payment, any number of errors could occur during processing. Furthermore, fraud rates were high in the paper-based environment. For transactions that were less than a pre-determined amount (e.g., $25), merchants were required to check the account number against a paper-based "bulletin" of invalid cards that was published and distributed at intervals; these notices were far from real-time. For larger value transactions, merchants were required to call the bank to obtain verbal authorization.

The introduction of magnetic stripe technology and electronic data networks dramatically altered the dynamics of the industry. In addition to increasing checkout speed, the new technology paradigm helped reduce errors due to manual intervention as well as fraud due to delays in availability of information. Payment information was transferred electronically via a magnetic stripe reader and authorization was requested at the point of sale through real-time information networks.

Technology Push of Alternative Identification Technologies

Today, a number of technologies can be used in place of magnetic stripe to facilitate payment processing. Barcode, optical character recognition, biometrics, smartcard, and RFID can all be used as a technology substitute for magnetic stripe – with a caveat. Deploying these alternative technologies would imply a different organizational and industry infrastructure for each technology. There are a number of considerations – both business and technical requirements – that might explain why some technologies have been commercialized in the payments industry and others have not.

Figure 4.1
Technology Attributes of Identification Technologies

	MAGSTRIPE	BARCODE	OCR	BIOMETRICS	SMART CARD	RFID
Typical data quantity (bytes)	~55	1-100	1-100	NA	16-64K	16-64K
Data Density	Low	Low	Low	NA	Very high	Very high
Machine Readability	Good	Good	Good	Good	Good	Good
Readability by people	Limited	Limited	Simple	Difficult[1]	Impossible	Impossible
Influence of dirt/humidity	Possible (stripe)	Very high	Very high	NA	Possible (contacts)	None
Influence of covering	Total failure	Total failure	Total failure	Possible	Total failure	None
Influence of direction	Bidirectional	Low	Low	NA	Unidirectional	No influence
Degradation	Stripe	Varies	Varies	NA	Contacts	No influence
Infrastructure costs (reading)	Low	Very low	Moderate	Very high	Medium	Low
Operating costs	Low	Low	Moderate	High	Low	None
Reading speed (including handling of data carrier)	Fast	Fast	Fast	Slow	Fast	Very fast
Maximum distance between data carrier and reader	Direct Contact	0-50cm	<3cm	Direct contact[2]	Direct contact	0-5m
Ease of counterfeiting	Moderate	High	Low	Low	Low	Low

[1] Voice is recognizable by people
[2] Except for voice recognition, which allows for some distance

Source: Adapted from media.wiley.com

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Data Quantity and Density

The data quantity and density metrics indicate the amount of information that can be stored on any given technology media (e.g., card, token, etc). This attribute can be significant in a payment scheme that requires large amounts of information to reside in the payment media. For example, in Europe and Asia, the EMV scheme requires high-density payment media to provide secure stored value transactions. Because of the high cost of telecommunications in these regions, access to relevant payment information at the point-of-sale is critical because the cost to connect to a central data store is high. In addition to storing basic payment information such as cardholder name and account number, the EMV standard uses the additional capacity and processing capabilities of a smart card to enable enhanced encryption and security measures.

There are, however, many other payment schemes that do not require high-density data storage in the payment media. Examples of these schemes include phone cards, gift cards, and mass transit cards. Gift cards and phone cards circumvent the need to store high volumes of information on the card by accessing a central data store which provides the balance on the card. Generally speaking, only the account number is actually stored on the payment media in these applications. Other schemes such as mass transit cards store the balance on the card; in these applications, stored values are relatively low and the need for enhanced encryption and security is not as compelling.

Machine Readability

In the early days of credit cards, imprint machines enabled merchants to capture cardholder information. Today, the ability to capture payer information is not enough; payment media must be able to transmit the relevant information in an electronic format.

All the technologies that I compared were capable of electronic data transfer. Some technologies, however, require complex supporting infrastructures to be used in a payment environment. For example, to use biometric technology for payment authentication, large amounts of information would need to be sent across data

networks to verify voice and other biometric patterns. In fact, banks piloted biometric technologies for automated teller machines (ATMs) in the mid and late 1990s, but eventually, the scale of the infrastructure required to deploy the technology for a mass market directed the industry towards other, more cost effective technologies.

Readability by People

In the electronic age, readability by people is generally considered a negative attribute. When sensitive information such as account numbers can be easily read by other people, there is (at a minimum) a perception that the potential for fraud and counterfeiting is high. Perhaps this is one of the reasons why optical character recognition has found limited use in commercial payment applications.

Usability (Influence of Dirt and Humidity, Direction, and Degradation)

There are many attributes that contribute to the *usability* of a technology paradigm for a specific application like payments. The influence of dirt and humidity on the readability of the payment media is an important consideration for assessing the robustness of the technology in a commercial environment. Barcode and OCR technologies perform poorly along this metric and consequently have limited use in payment applications.

Directional requirements also have an impact on usability. Magnetic stripe and smart card technologies must be oriented in a specific way(s) in order to transmit information to the reader. This limitation represents an opportunity for technologies like RFID to outperform prevalent payment card technologies.

Finally, degradation is also an important consideration when assessing commercial robustness and usability. The contact points of chip cards are susceptible to degradation. Magnetic stripes are not only susceptible to degradation, they can also be de-magnetized. Relatively speaking, however, smart card and magnetic stripe technologies perform reasonably well with regard to degradation. On the other hand, bar code and OCR "encoded" information can be highly susceptible to degradation

when printed on paper-based materials such as labels. However, when printed onto a card's surface, performance is comparable to (if not better than) magnetic stripe cards.

Implementation Costs (Media, Infrastructure, and Operation Costs)

Cost is one of the most important metrics used to assess the commercial potential of a technology paradigm. The total cost of deploying a selected technology includes the cost of media, the cost of the infrastructure, and any ongoing operating costs such as telecommunications, maintenance, etc.

The technologies I compared have different cost structures when used for payment processing. A biometric scheme, for example, may require minimal costs for consumer payment media, but the infrastructure and ongoing operating costs are high. On the other hand, smart card schemes require a relatively high investment in media as well as infrastructure (i.e., point-of-sale systems), but because stored value functionality enables secure offline transactions, telecommunications costs can be reduced significantly. Indeed, reducing communication costs is one of the primary motivators behind the EMV initiative in Europe and Asia where telecom costs are high compared to the U.S.

However, one cannot judge the long-term commercial viability of a technology paradigm based on current cost structures alone. Technology costs generally drop as a dominant design evolves and technology suppliers focus on improvements in process innovation (Utterback, 1994). For the payments industry, this suggests that if a technology were to be adopted by a large-scale payment system, thereby creating a dominant design of sorts, costs will drop as the market moves into a transition phase. Therefore, when assessing alternative technologies, payment providers ought to consider the potential savings from operational costs in addition to other non-cost related benefits.

High switching costs will always be a significant barrier to the adoption of a new technology paradigm, especially for large-scale payment schemes. The credit card industry has historically handled the introduction of new technologies by allowing the

new to coexist with the old. For example, when magnetic stripe technologies were rolled out, credit card companies did not do away with imprint technology. Today, even in the U.S., where the vast majority of transactions are initiated electronically via magnetic stripe technologies, plastic cards still have "raised" account numbers and merchants are still issued imprint machines when they decide accept credit card payments.

Reading Speeds

The speed that information can be read has a dramatic impact on checkout times at the point-of-sale. However, most of the technologies in my comparison perform well along this metric, and I believe that any increases in reading speed will only provide excess performance that is not required by the current applications. Today, the bottleneck in the checkout process for most payment schemes is not in the transfer of payment information from the customer to the merchant, but rather in the information transfer on the back-end to authorize and authenticate a transaction.

Distance from Reader

Magnetic stripe, smart card, and biometric technologies such as fingerprint and retina recognition require contact between the payment media and a reader. Bar code, RFID and voice recognition are considered proximity (or contactless) technologies and do not require contact.

The value of the distance attribute in a payment scheme is still unclear for many payment applications. General purpose payment providers such as MasterCard, Visa, and American Express as well as niche players such as mass transit systems have generally implemented close proximity solutions. In some cases, the technology is configured as a "tap-and-go" rather than a true contactless technology. One reason for this rather conservative approach is that an increase in distance between the media and the reader can raise error rates to unacceptable levels. Thus many payment companies are still wrestling with the trade-off between faster throughputs and greater error rates. There are industries, however, in which the proximity attribute of RFID is being used to

its full potential. Toll collection, for example, is utilizing the proximity attributes of RFID to facilitate the payments processing.

Counterfeiting (vs. Fraud)

As counterfeiting is a serious issue for the payments industry, ease of counterfeiting is an important consideration when evaluating a technology for commercial use. Armed with the prerequisite information (i.e., cardholder name, account number, issuing institution, etc), bar code media is probably the easiest to counterfeit. Magnetic stripe technology requires more sophisticated processes and technologies to counterfeit, but it is moderately difficult at best.

A technology can be difficult to counterfeit, but this attribute does not prevent a thief from stealing a payment product and using it fraudulently. Every technology I discussed is susceptible to fraud. Even biometric technology, which can be effective in addressing fraud for in-person transactions, is susceptible to fraud. For example, armed robbers can still force consumers to withdraw money from an ATM.

Designing Platforms to Deliver the Right Services

Consumers have a wide variety of payment and related needs. Those who tend to spend beyond their means require a credit line. On the other hand, there are some who prefer use to a payment card for convenience and do not wish to incur any interest charges. Like Apple and OnStar, the payments industry has been very successful at creating an integrated product platform and services model that seamlessly addresses all of these needs. A general purpose credit card provides both financing and interest-free funds transfer services delivered through an extensive network of point-of-sale (i.e., payment card and merchant terminals) and data communication technologies. The selection of standards and technologies has allowed the platform to be extended as new services evolved. For example, in the mid 1990s, as the demand for frequent flyer miles and other reward offerings grew, the underlying technology infrastructure was extended to support these new business requirements.

Merchants are also very important players in the payment ecosystem as they ultimately foot the bill for technology infrastructure costs. Not only do they have to pay banks (and other intermediaries) 2%+ of all credit card sales[9], they must also purchase or rent point-of-sale terminals and other related payment processing technologies. While it can be argued that the costs are eventually passed onto the customer, the needs of the merchant are nevertheless an important influence the technology paradigm that is adopted.

Merchants also have a heterogeneous set of needs. Some require speed at the point-of sale. Industries that might fall into this category include mass transit, fast food, and convenience stores. Others are price sensitive and prefer the lowest cost solution to facilitate payment transfer. These firms are typically characterized by high average transaction values and little need for speed at the point-of-sale (e.g., department and furniture stores). Historically, payment cards have successfully addressed the needs of the latter segment. In the U.S. the needs of merchants that require high speeds such as fast food restaurants have gone unmet until recently. With the integration of RFID into the existing platform, the payments industry appears to have successfully extended their infrastructure once again. We discuss the impact of this innovation in detail in Chapter 5.

The Challenge of Platform Design

The technology that underlies a service firm's product platform has significant implications on the potential for new services. In designing (and evolving) the technology platform, aligning the strengths of the selected technology to specific requirements of the business model is important, but the business model itself must reflect the needs and desired experience of the customer. Utterback *et al.* (2006) suggest that simplicity and elegance are of utmost importance when designing a product. In service industries, the technology platform can play a significant role in this respect. Onstar's physical user interface continues to rely on only three buttons, despite the growing array of services that it offers. Many of the complexities of service

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[9] For other payment products such as debit cards and checks, per transaction costs also apply

delivery are simplified through interaction with the call center advisor – a simple and elegant solution.

Chapter 5:
Winning through Architectural Innovation

Scholars like Utterback, Christensen and many before them have made a distinction between incremental improvements and new concepts that lead to industry disruption in the manufactured products domain (Mansfield, 1968; Moch and Morse, 1977; Freeman, 1982; Henderson and Clark, 1990). Incremental innovation improves on established designs and reinforces the dominance of incumbent firms (Nelson and Winter, 1982; Ettlie, Bridges, and O'Keefe, 1984; Dewar and Dutton, 1986; Tushman and Anderson, 1986, Henderson and Clark, 1990, Utterback 1994; Christensen, 1997). Radical innovation, on the other hand, is based on new engineering and scientific principles and often opens up new markets (Dess and Beard, 1984; Ettlie, Bridges, and O'Keefe, 1984; Dewar and Dutton, 1986; Henderson and Clark, 1990, Utterback 1994; Christensen, 1997).

By definition, a disruptive innovation creates some type of competitive advantage for the attacking firm. Because technology is a disaggregated function for many service industries, a sustainable competitive advantage cannot be acquired by simply embracing a single component technology or implementing the latest software application. Fine and Whitney (1996) observe that valuable technology is diffused into the marketplace via outsourcing decisions and any competitive advantage is eventually lost. It follows, therefore, that firms who acquire and implement basic third-party technologies gain little to no competitive advantage.

In this chapter, I will revisit the concept of architectural vs. component innovation developed by Henderson and Clark (1990). Architectural innovation is the key to the development of product delivery platforms. In the earlier examples of product-based services, every delivery platform was a synthesis of third-party, component technologies. The contribution of Apple, OnStar, and the payment card industry to their respective products was linking the component technologies together – that is, defining the architecture of the new product. This approach to innovation has resulted in assets of strategic importance for the respective firms.
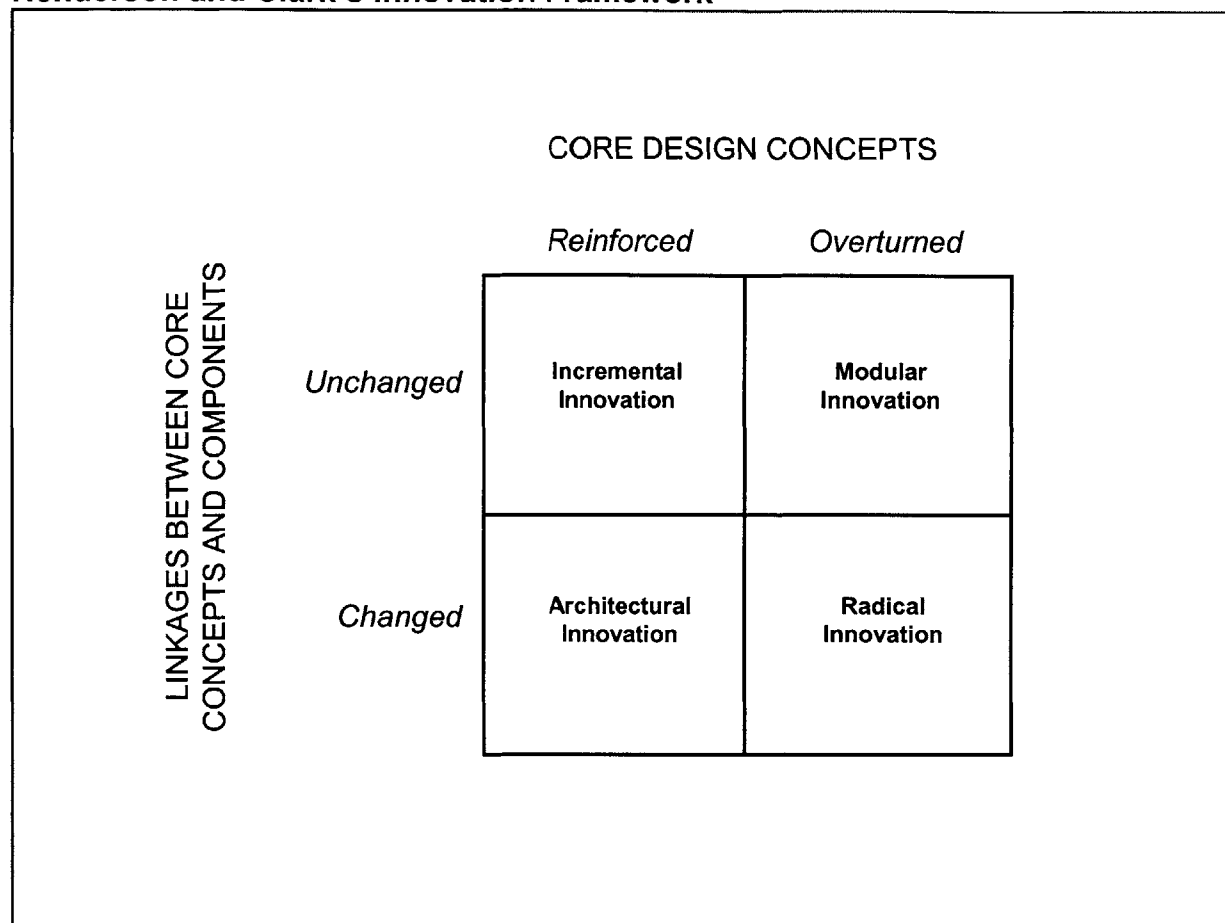
Next I will attempt to extend Henderson and Clark's framework to complex networks of systems and firms. Using the payments industry (again) as an example, I will use the framework to explain why new component technologies such as RFID have not lead to any industry disruption.

What Is Architectural Innovation?

Hendersen and Clark note the distinction between a product as a system and a product as a set of components. A component is a physical part of a system that embodies a core design concept, which is defined as an approach or technology paradigm for achieving a specific function. For example, there are several design concepts that could be selected for a motor of a mechanical fan. An electric motor is one option; gas and battery-powered motors are two others. The architecture of a product is the way in which the components are integrated.

Hendersen and Clark claim that radical innovation involves a fundamental change in both architecture and components. On the other hand, incremental innovation occurs when the fundamental architecture is unchanged and the components are refined. Henderson and Clark introduce two "new" categories of innovation. Architectural innovation occurs when linkages are changed but core concepts are reinforced; modular innovation occurs when core concepts are overturned but linkages remain unchanged.

Figure 5.1
Henderson and Clark's Innovation Framework

CORE DESIGN CONCEPTS

	Reinforced	Overturned
Unchanged	Incremental Innovation	Modular Innovation
Changed	Architectural Innovation	Radical Innovation

LINKAGES BETWEEN CORE CONCEPTS AND COMPONENTS

Source: Henderson and Clark, "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms"

The additional "quadrants" of Hendersen and Clark's framework help explain some of the difficulties of classifying innovation into two categories – incremental vs. disruptive. Radical innovations are typically easy to identify. They give birth to new industries and often invade the markets of older technologies over time. The dominant positions of established players are usurped by new startups or firms from other industries. Grouping all innovations that are not radical into the incremental category is more difficult to rationalize. There are innovation efforts that seem to do more than create new efficiencies; some, for example, actually reinforce the position of the incumbent players and appear to keep attackers at bay. We will analyze such an innovation later in this chapter as we discuss the adoption of contactless payments in the credit card industry.

The intent of this chapter is not to identify how each type of innovation in Henderson and Clark's framework is realized in the services industry. While this might be a worthy endeavor for future work, it is beyond the scope of this paper. Rather, some of the underlying principles in the framework are useful for understanding why incremental innovation is the norm while radical innovation is difficult for successful firms. Moreover, the framework provides a more useful classification for attributing the merit or impact of a lesser innovation. CompuCredit's implementation of BPM software was clearly incremental innovation at best. However, their proprietary credit score models were more than incremental, but they were not disruptive.

To extend Henderson and Clark's framework to the payments industry, we must consider the vertical and horizontal axes of the framework more broadly. I propose that it is appropriate to consider 1) the entire organization as a complex system and 2) departmental functions as component technologies. The idea that a firm should be treated as a complex system is not a new idea in systems thinking. In "Unifying Themes in Complex Systems," Herb Simon explores several attributes of a complex system and argues that organizations exhibit these same characteristics. Simon notes that complex systems have properties and mechanisms that enable it to perform complex functions or facilitate rapid development toward such ability. He highlights four principles of complex system design: homeostasis (the ability to hold values of important properties within narrow limits), membranes (which insulate a system from its environment and move substances or information from the external environment to the internal environment), near-decomposability (that most systems that occur in the world have hierarchical structure, that is, a "boxes-within-boxes" arrangement of subsystems), and specialization (which needs no special explanation). Simon argues that like physical systems, organizations also exhibit these properties. I propose that organizations and even entire industries can be viewed as a complex system. Under this lens, people and departmental units as well as intermediary organizations with specific roles can also be viewed as "components technologies." In fact, one lesson that can be generalized from the CompuCredit example is that as a departmental

function matures, it is often the case that people (or headcount) are replaced by systems to perform the specified function more efficiently.

Technological and Organizational Trajectories

Henderson and Clark suggest that the selection of component technologies commits the firm to a specific technology path. Once a firm has found success with a component technology (i.e., the core design concept is selected), resources are typically committed to incremental improvements in the stable paradigm rather than exploring new alternatives:

> With the emergence of a dominant design, which signals general acceptance of a single architecture, firms cease to invest in learning about alternative configurations of the established set of components. New component knowledge becomes more valuable to the firm than new architectural knowledge. Successful organizations therefore switch their limited attention from learning a little about many different possibilities to learning a great deal about the dominant design.[10]

The anatomy or architecture of a service organization also appears to exhibit characteristics of paradigm constraint. It is often the case that when an organization finds success with a business model, it builds competency (e.g., skill sets of employees) and infrastructure around that specific paradigm. Scholars who have studied product industries have noted that over time, these core competencies make it difficult for firms to respond to waves of change (Utterback 1994; Leonard 1995; Christensen 1997). I propose that this same principle is in play with respect to the anatomy of a service firm. When a service firm selects a specific paradigm to go to market, it tends to cease (or significantly reduce) investment in other paradigms (e.g., alternative skill sets). Resources are committed to refining the stable paradigm and supporting infrastructure is built to enhance operational efficiency.

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[10] Henderson and Clark, 1990

When an organization is viewed as a complex system with paradigm constraints, it is easier to see how the reinforcement of existing paradigms results in only incremental innovation. Let us examine the recent rollout of RFID in the payment card industry to see how these principles apply. Using the extended framework proposed above, I offer an explanation for why contactless payment technology will not cause an industry disruption.

Understanding the Impact of RFID in the Payments Industry
Dosi argues that there are a number of other selective or focusing forces that help determine the success of a technology paradigm. Of particular relevance to our current discussion are "institutional forces." Dosi observes that institutions can play a significant role in committing an industry to a single technology paradigm.

The large scale rollout of RFID technology into the payment card industry has been a direct result of institutional commitments to a single technology and standard. MasterCard, Visa, and American Express are important focusing forces in the payment card industry. On paper, MasterCard and Visa are competing brands, but both associations are essentially "owned" by the same group of credit card issuing banks they serve. The decision by MasterCard, Visa and American Express to adopt the ISO/IEC 14443 standard has effectively shifted the majority of the consumer cardholder market to RFID.

The intent behind the introduction of contactless payments is to displace alternative payment media such as cash and paper check. Credit and debit cards have been very successful at capturing share of large dollar value transactions, but for small value transactions, cash is still king. By offering a product that is more convenient than cash at the point of sale, credit card issuers are attempting to challenge the status quo.

However, contactless payment technology is a modular innovation at best. It is a clear case of a component technology that is introduced into an established business paradigm. The technology platform including POS terminals and payment networks is

retained, and, moreover, the established payment ecosystem – that is the architecture of industry – is exploited rather than changed. As a result, the positions of the incumbent firms are strengthened and not weakened. An initial look at the entry and exit of firms in recent years might suggest that a new wave is emerging, but as we will show in the following analyses, the new technology is in fact symbiotic.

Industry Entries and Exits

The trends in entries and exits of firms provide insight about the dynamics of an industry. Trends observed in the manufacturing of RF-based contactless payment cards are similar to those of the hydraulic excavator (Christensen, 1997) and the electronic calculator (Utterback, 1994), both of which were disruptive technologies.

One of the first major RF-based contactless credit cards was Blue by American Express, introduced the late 1990s. AmEx Blue set off a new wave of credit card manufacturing activity specifically geared towards contactless payments. As interest grew, more firms entered the business of financial payment card manufacturing.

Figure 5.2
**Entries and Exits of RF-based Bank Payment Card Manufacturers – 1998 to 2004**

Credit Card Manufacturers Entries and Exits
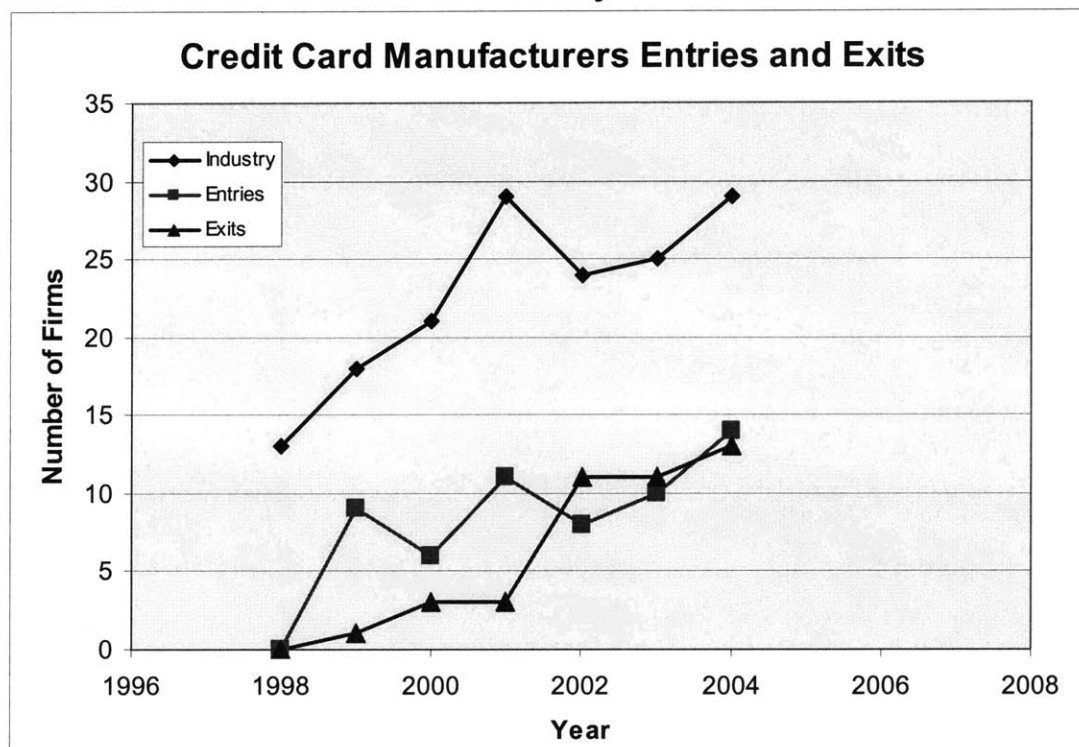
Source: The Nilson Reports

Firm entries outpaced exits from 1998 to 2004. According to the Nilson Report, in 1998, there were 13 firms each producing between 100,000 and 400,000 contactless payment cards. In 1999, one firm exited the industry and nine entered, increasing the total number of firms by over 60%. Over the next few years the number of entries outnumbered exits, and the total number of firms in the industry hit a local peak of 29 in 2001, with the top manufacturing firm producing 15.5 million cards. Since 2001, entries each year have varied between 8 and 14, while exits have increased by about 400% (with 11 in 2002 and 13 in 2004). Overall, growth continued on an upward trend during this period.

Firm entry into a market is often correlated to a growing interest in the technology and increasing rates of market-driven production (Utterback, 1994). As shown by the extrapolation below, firm exits from the payment card manufacturing industry could suggest the beginnings of a "wave of change" that Utterback observed in the typewriter, automobile, television, transistor, disk drive, and supercomputer industries.

Figure 5.3
Extrapolation of RF-based Payment Card Manufacturers – 1998 to 2004
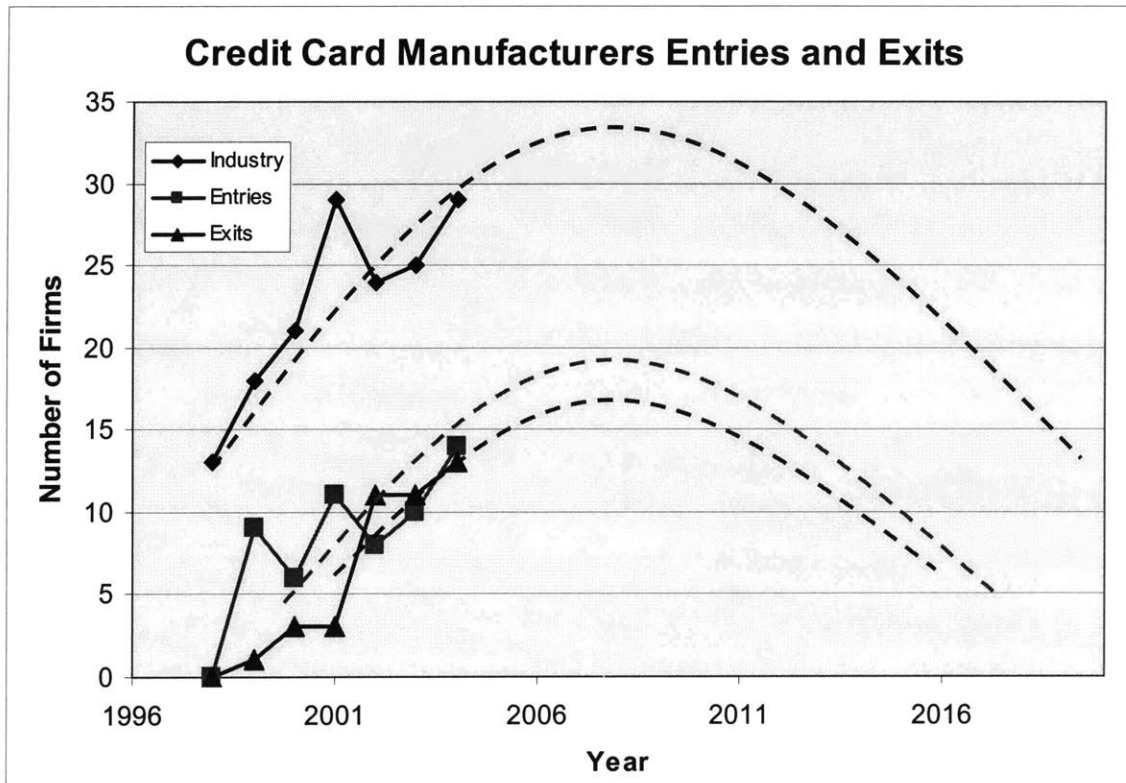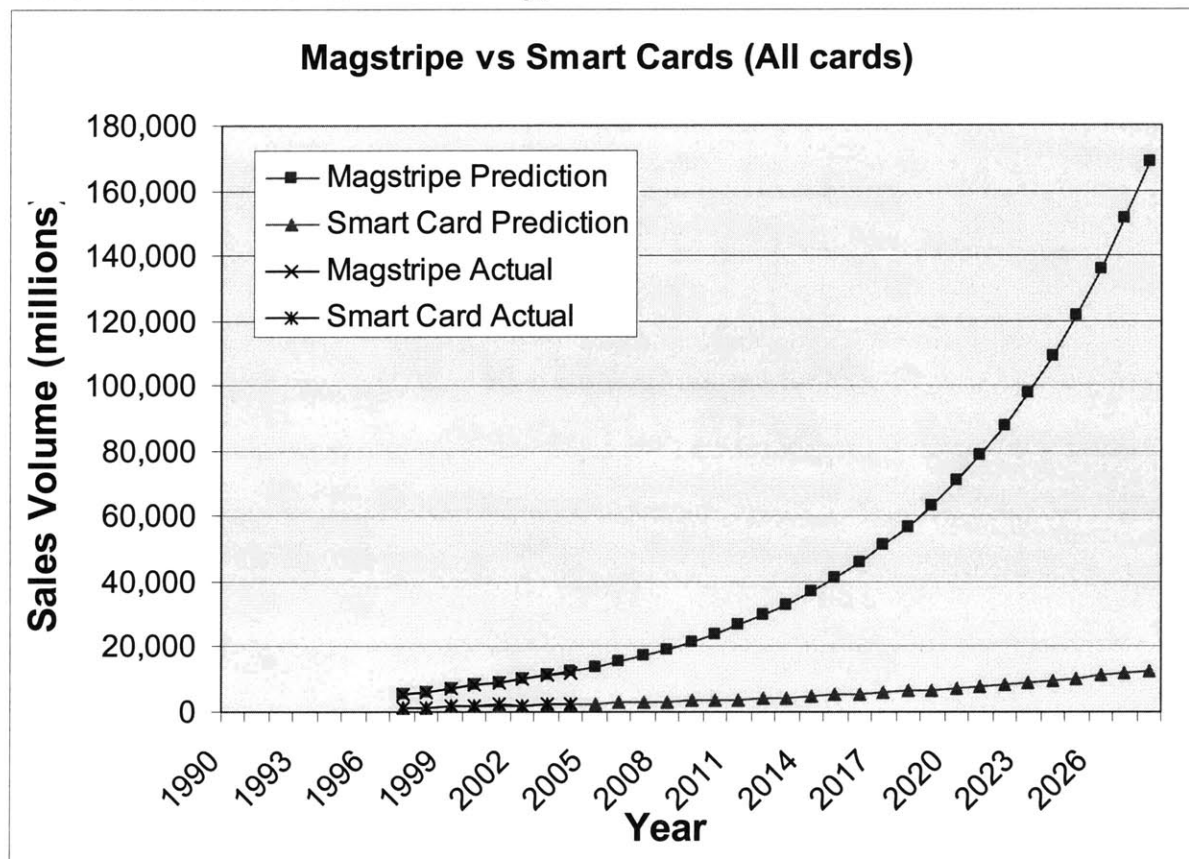

Source: Data from The Nilson Reports

Lotka-Volterra Model: Competing, Symbiotic or Predator-Prey Technologies?

Alternative technologies are not always competitive. Pistorius and Utterback observe that the interaction between two technologies generally falls into one of three categories: pure competition, symbiosis or predator-prey (Pistorius and Utterback, 1997). A mathematical model based on a modified Lotka-Volterra (LV) formulation can be used to model these interactions (Pistorius and Utterback, 1996). We can use this model to examine the interactions between contactless payment and magnetic stripe technologies in the payments industry.

Production data from the Nilson Reports for the years from 1997 through 2004 was used to develop a forecast using the Pistorius and Utterback's modified LV Model. There are many applications for contactless technology. Phone cards, mobile communication payment cards, banking/credit cards, identification/entry cards, loyalty cards, transportation cards and pay television cards are among the most popular. For
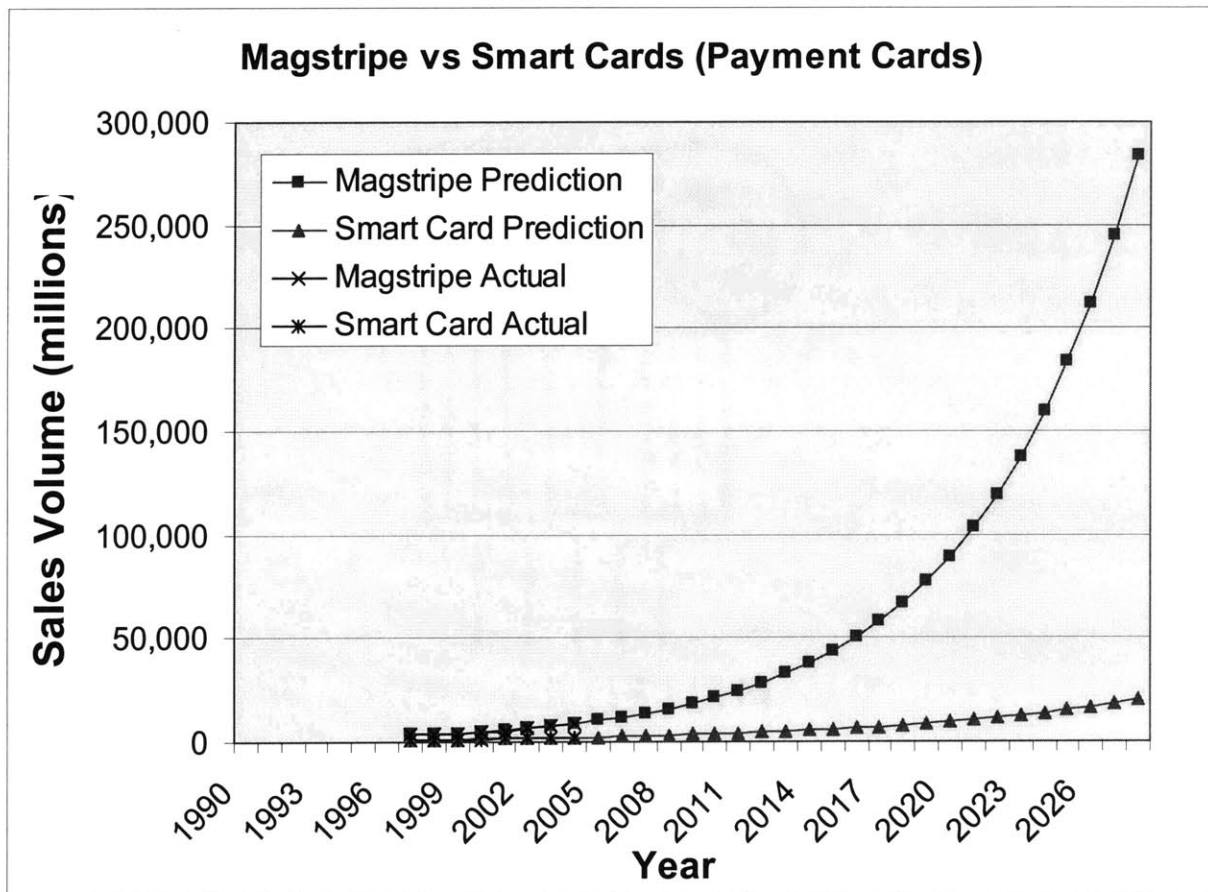
all applications (payment and non-payment e.g., loyalty, identification, etc), the LV forecast suggests that a symbiotic relationship between contactless and magnetic stripe cards. A symbiotic relationship is one where an emerging technology has a positive effect on the growth of a mature technology and vice-versa. For a symbiotic relationship to truly exist in the long term, each technology must benefit in some way from the other.

Figure 5.4
Lotka-Voltera Forecast: All Card Types

Source: Data from The Nilson Reports

Figure 5.5
Lotka-Voltera Forecast: All Payment Cards (excludes non-payment)

Magstripe vs Smart Cards (Payment Cards)

Legend:
- Magstripe Prediction
- Smart Card Prediction
- Magstripe Actual
- Smart Card Actual

Y-axis: Sales Volume (millions) — 0, 50,000, 100,000, 150,000, 200,000, 250,000, 300,000

X-axis: Year — 1990, 1993, 1996, 1999, 2002, 2005, 2008, 2011, 2014, 2017, 2020, 2023, 2026

Source: Data from The Nilson Reports

Figure 5.6
Lotka-Voltera Forecast: Bank Payment Cards Only

Magstripe vs Smart Cards (Financial Cards)

Legend:
- Magstripe Prediction
- Smart Card Prediction
- Magstripe Actual
- Smart Card Actual

Y-axis: Sales Volume (millions) — 0 to 50,000
X-axis: Year — 1990 to 2028
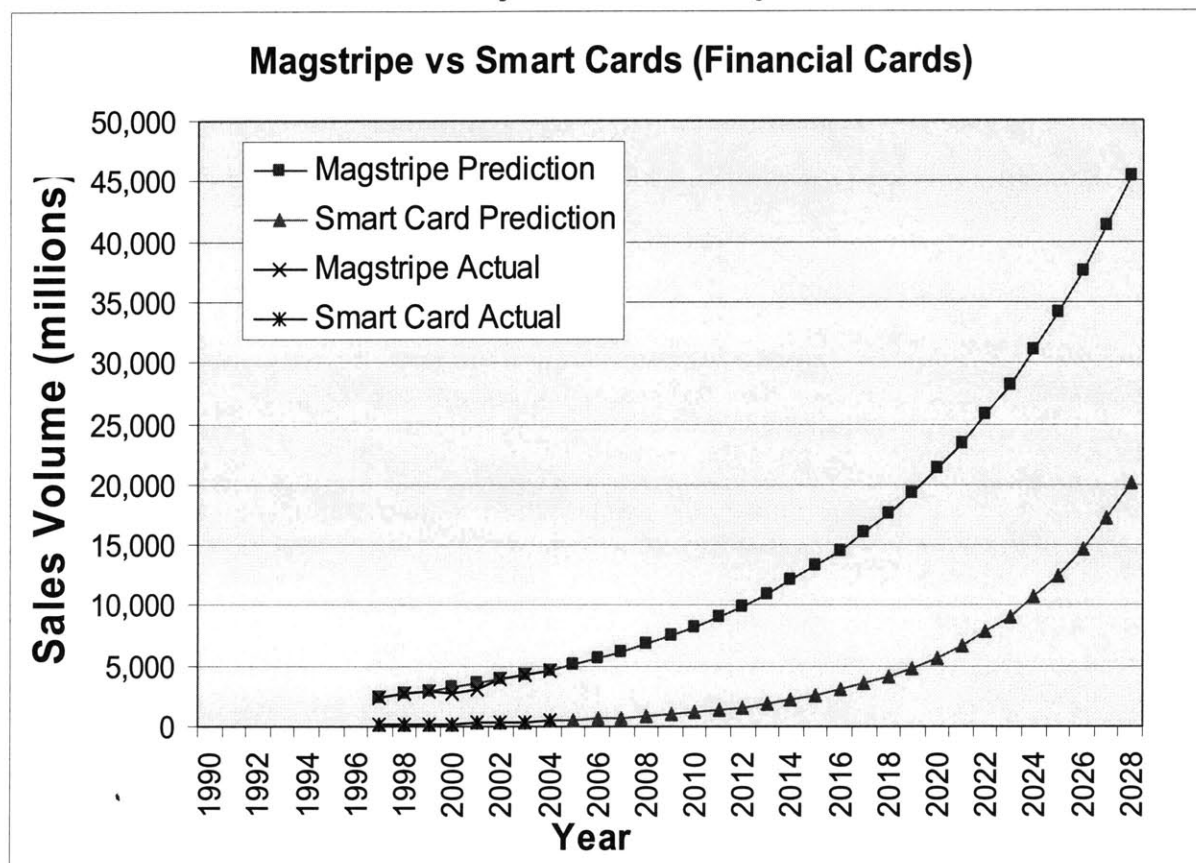
Source: Data from The Nilson Reports

While the LV model predicts a potentially symbiotic relationship across the board, there appears to be a stronger interaction between the two technologies in the financial payment card sector, where contactless technology has achieved more penetration and thus a larger share of card production. The rapid deployment and adoption of contactless cards can be attributed to the fact that established payment networks and card reader technologies (point-of-sale terminals) are being leveraged as a part of the "new" infrastructure. Meanwhile, magnetic stripe technology continues to grow in most applications where RF-based contactless payment technology has not yet shown an overwhelming advantage. The two technologies have complementary attributes which hold potential for a symbiotic relationship where the attributes of each one offer an advantage under different scenarios. As a result, most RF-based contactless cards issued by credit card issuers today incorporate both technologies on the same card.

It is difficult at this point to conclude with certainty whether the current trend truly represents a symbiotic relationship or whether it is merely a short period of tolerance before the success or failure of RF-contactless technology becomes clearer. The dynamics of interaction between the two technologies may also change over time, as suggested by Pistorius and Utterback. The symbiotic relationship forecasted by the LV model could transform itself into one of predator-prey or pure competition. Thus, if one technology or the other achieves increased performance such that it no longer requires the symbiotic interaction to satisfy market needs, the improved technology can begin to negatively affect the growth of the other technology. In the case of magnetic stripe cards and RF-based contactless cards, it is possible for either of these technologies to improve to the point where the mode of interaction departs from symbiosis and one displaces the other through substitution.

The symbiotic relationship between magnetic stripe and RFID suggests that the newer technology is not disruptive but incremental. Over time, RFID technology is being adopted universally by established firms, reinforcing their leadership position in the industry. The existing industry structure is reinforced, and there is appears to be no architectural change on a technical, organizational, or industry level.

In Search of Radical Innovations

The excitement of a disruptive innovation that will create a sustainable competitive advantage continues to motivate organizations to invest in product and process improvements, but unless these efforts are properly guided, only modest enhancements and temporary advantages will result. When considering where to invest, managers ought to consider projects that will result in architectural change. Ideas that challenge the existing industry, organizational, and technological architectures should not be dismissed too readily.

Chapter 6
Knowledge-based Innovation

The ability of a service firm to develop innovative products is tied to its ability to manage knowledge acquisition. James Brian Quinn suggests that both product- and service-based organizations can be viewed as a collection of individual service activities that add value to the overall enterprise by managing domain-specific expertise.

> "Services activities" include personnel, accounting, finance, maintenance, legal, research, design, warehousing, marketing, sales, market research, distribution, repair, and engineering activities, which may be performed as functions inside an integrated – manufacturing or service – firm or by a separate firm (like a market research or accounting firm). The common element among all these activities and industries is the predominance of managing intellect – rather than managing physical things – in creating their value added.[11]

Dorothy Leonard goes on to suggest that all companies compete on the basis of its ability to manage knowledge.

> Expertise collects in employees' heads and is embodied in machines, software, and routine organizational processes. Some of this knowledge and know-how is essential simply to survive or achieve parity with the competition. However, it is core or strategic capabilities that distinguish a firm competitively.[12]

For the purpose of this paper, I define a knowledge-asset as any type of intellectual capital that might give a firm a unique advantage in the marketplace. To understand the types of knowledge that must be pursued to develop a meaningful advantage in the marketplace, I reviewed the patent activity of Onstar, an example that was discussed in Chapter 3. I chose to look at OnStar for a number of reasons. First, OnStar has developed a complex product platform, a topic that is of particular interest. Second, unlike MP3 players, telematics services have not yet become a commodity; it is a

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[11] Quinn, 1992
[12] Leonard, 1995

maturing industry, but there is sufficient data from which to draw some meaningful conclusions. Third, OnStar's technology platform appears to leverage existing technologies, an important tenet of product innovation discussed in Chapter 2. This observation begs the question: how can a service organization win (rather than simply stay competitive) by leveraging established technologies?

Observations From Onstar

OnStar's patent activity falls into several categories including safety, vehicle diagnostics, voice recognition, vehicle navigation and wireless infrastructure. While research and development appears to take place in many different disciplines, I propose that several types of knowledge assets contribute to innovative product development: component technology know-how, architectural know-how, and data-based know-how.

Component technology know-how and architectural know-how are both technology-related knowledge assets. The importance of technology-related knowledge assets has been studied by scholars extensively and in fact, the concept is a fundamental building block for innovation theory. Many have observed that technology know-how is typically acquired through research and development efforts. Performance curves (i.e., S-curves) are often used to convey the impact of technology know-how on product performance at the industry level. In the early stages of a product, engineering efforts result in only a modest gain in product performance. Technology know-how is acquired slowly during this period. Over time (or effort), the impact of engineering efforts yields significant advances in product performance. Technology know-how is acquired more quickly and the rate of advancement in product performance increases dramatically. In the final phase of a product's evolution, engineering efforts once again yield only incremental advances in product performance. Most of the applicable technology know-how has been acquired and any effort to learn more does not result in significant improvements in product performance.

Figure 6.1
The Technology S-Curve

Product
Performance

Time or Engineering Effort
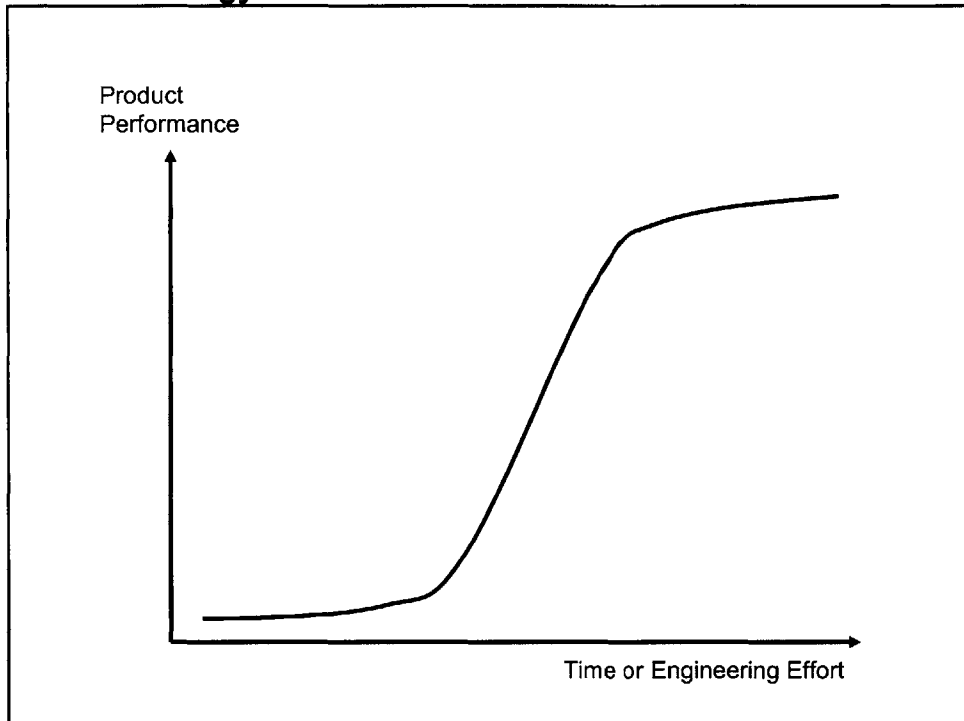
Component technology know-how, as suggested by Henderson and Clark, is an understanding of the components or parts that comprise a system. Component technologies employ a specific approach or design concept to achieve a specified function (i.e., using an electric vs. a battery powered motor to drive a mechanical fan). To build the systems that are the basis for its business, OnStar needed to have a working understanding of many component technologies. These included global positioning systems, wireless technologies, the digital and mechanical subsystems of an automobile, sensor technologies, and others.

It is important to note that the much of OnStar's patent activity is not related to improving component technology know-how, but rather the way the individual components are integrated (see *Architectural Know-How* below). On the other hand, General Motors (GM), OnStar's parent company, is intimately involved in developing the component technologies in an automobile. The depth of OnStar's automobile component technology know-how clearly differs from that of GM. This difference can be

explained by the fact that OnStar is a "consumer" of GM's component technologies while GM is in the business of acquiring deep component level know-how to improve their automobile subsystems.

The use of third-party component technologies in product architectures is common in modern product development practices, and the relationship between a consumer and a supplier of component technology can often be characterized by component technology know-how. The specific use or application of the component technology often determines the depth and scope of component knowledge that is required by the consuming organization.

Architectural Know-How is an understanding of how component technologies are integrated and linked together. As I suggested earlier, OnStar's proprietary platform is not the result of component technology know-how, but rather the integration of different component technologies. It can be argued that OnStar developed some of its own component technologies (e.g., sensing diagnostic module), but many of these components were designed as a part of a larger integration or architectural initiative.

OnStar acquired architectural know-how in the development of infrastructure. For example, in developing the capability to communicate wirelessly between the call center and the customer's vehicle, OnStar had to build an infrastructure to transmit voice and data to an available advisor. This initiative involved the integration of wireless, call center, and other onboard communications systems. Existing methods (i.e., design concepts) for transmitting both voice and data required a modem line associated with each voice line, resulting in more lines and modems than was practical for a large-scale operation. To create scalability, OnStar decided to use a centralized modem pool that required switching between the advisor and the modems used for communications. The technical challenge in this network architecture was the need for rapid and accurate switching between voice and data. "Switch-to-voice" and "switch-to-data" signals were developed and integrated into both the call center systems and the mobile vehicle systems. A "switch-to-voice" signal originating from the call center, for example, would

trigger an acknowledgement by the mobile vehicle followed by a series of network level changes that would enable data transmission to be received and processed by the call center advisor.

Another example of architectural know-how involved the development of a method for maintaining communication with a vehicle at all times. Wireless communication services for devices in mobile vehicles such as navigation systems have been available for years, but the ability to request services when the vehicle (and device) is turned off or in "sleep" mode was needed for OnStar's business model. When a vehicle is off, a number of functions including maintenance and diagnostic functions, system updates, the unlocking of doors, and vehicle alarm setting and silencing cannot be performed. To address this issue, a satellite radio system broadcast channel is used to monitor for a command signal when the device is powered down. The command signal includes specific unit identifier information such as a vehicle identification number, a mobile phone identification number, an electronic serial number, or a satellite radio receiver identification number. When the command signal is received on the broadcast channel, the onboard unit is powered up.

In addition to technology know-how, *data-based know-how* is an invaluable knowledge asset that can provide a significant competitive advantage for a service company. Financial institutions, for example, possess a wealth of transaction data that can provide insight into their customer base. This data can be used for extending new services to a customer (e.g., cross-selling) as well as limiting available services available (e.g., applying credit limits). For On-Star, data-based knowledge enables the company to provide a valuable service to their customers. Over time, OnStar has accumulated data from the vehicle diagnostic systems that monitor vehicle components and subsystems. Using this data, OnStar is able to project the remaining useful life of a component or system by comparing key performance characteristics from monitored components to stored historical values. When a fault is projected, an indication of the remaining useful life of the component or system is transmitted to the customer. This service enables the

customer to aware of a potential system failure prior to significant degradation of the component.

Other Types of Knowledge Assets

The concept of a *core competency*, though not synonymous with the notion of a knowledge asset, is very similar. A core competency is a specialized area of expertise that meets three conditions: 1) it adds value to the end product; 2) it is difficult for competitors to imitate; and 3) it can be leveraged widely for many products and markets (Hamel and Prahalad, 1990). As scholars have developed the concept over the years, it has been suggested that a firm's core competency can take various forms, including technical/subject matter know-how, a reliable process, and close relationships with customers and suppliers (Mascarenhas *et al.* 1998) and even build vs. buy decision making capabilities (Fine and Whitney, 1996).

Building on the ideas developed in the core competency framework, OnStar's patent activity suggests that *technical and subject matter know-how* are clearly important to the innovation process. My research suggests that knowledge assets are also involved in developing *reliable processes*. CompuCredit's credit scoring model is an example of a proprietary method. Unique principles or procedures employed by specific disciplines to provide some sort of competitive advantage, proprietary methods are developed over time through experience and experimentation. CompuCredit's credit scoring models represent knowledge assets that enabled the firm to effectively manage the risk of nonpayment. Walmart's supply chain management know-how is another example of a reliable process. Noted for its excellence in distribution, Walmart's dominance in the retail sector can be attributed in part to its best practices in integrating logistics. The legendary retailer is able to replenish items on their shelves in only a few days. What is remarkable is that the inventory often comes not from the central warehouse but from the manufacturers themselves! The quick turnaround allows Walmart to keep lower inventory levels and still meet customer demand. The knowledge that underlies its operational excellence on supply chain issues is central to this core competency.

In practice, a knowledge asset like a core competence can also exhibit some of the characteristics of a constraining component technology. Henderson and Clark suggest that the selection of component technologies commits the firm to a specific technology path. Once a firm has found success with a component technology (i.e., the core design concept is selected), resources are typically committed to incremental improvements in the stable paradigm rather than exploring new alternatives. For a core competency, Dorothy Leonard (1995) suggests that a firm's capabilities are also its rigidities. As the market environment changes and business requirements evolve, managers find themselves wrestling with the underpinnings of its success. Building on these principles, I would propose that when an organization finds success with a specific knowledge asset, it typically focuses on refining the stable model and building infrastructure around it. Investment in alternative paradigms and infrastructure is kept at a minimum. Developing alternative knowledge assets when business requirements evolve are as much a challenge for service firms as it is for product companies. Further work is needed to validate my interpretations of these principles, but my research suggests there is merit to these claims.

Managers responsible for the acquisition and/or development of knowledge assets need to be aware of critical knowledge that is passed over because of the firm's inability to identify it (Leonard, 1995). Far too often, the focus is narrowly on present success. Though resources are dedicated to R&D to stay abreast the latest developments in the field, established approaches to activities such as problem solving and experimentation are often centered on the existing paradigm and actually impeded the acquisition of critical new knowledge.

Chapter 7:
Conclusion and Future Work

Service industries exhibit some remarkable similarities to manufactured product industries with respect to patterns in innovation. Innovations in both service and product industries seem to leverage existing ideas and technical capabilities. We revisited the history of payment cards and showed how the evolution of the credit card was a synthesis of existing concepts and technologies. Like product industries, service industries also seem to converge around a dominant design, especially in industries and applications where technology is involved. We traced the evolution of credit cards and saw how the payments industry converged from paper vouchers and charge plates to cards that used imprint technology. As product markets mature, the landscape of players shifts with the emergence of a dominant design. We noted that when the credit card industry emerged as the model of choice for consumers in the late 1970s, general purpose credit card issuers also began to usurp the payment business from retailers. Product industries also seem to experience waves of technological change. We observed how the credit card industry also went through several waves of technical change, moving from purely paper-based transactions to imprint technologies to magnetic stripe.

The distinction between product and process innovation also exists in services. The distinction between product and process might not be as clear in services as it is in manufactured products. One might think of the service "product" as the options and features of a service and the "process" as the way in which the service is delivered. Information technology is a key process enabler and a central focal point of much of the innovation that occurs in service industries, particularly in the knowledge-based services. One very common application of IT is to automate otherwise paper-based, manual, and error prone processes. The CompuCredit example captured some of the key benefits of modern IT-enabled process innovation efforts.

Product-based services like the Apple iPod and OnStar's vehicle telematics service represent the convergence of the product and service domain. Product-based services

are enabled by technology delivery platforms, which can help simplify the development of new service features and keep the cost of delivery low. One might think the patterns of innovation for this segment mirror those of traditional product industries, but in this paper, we have attempted to show that there are some important differences.

Technology is typically not a core competency of service companies. As a result, service firms often turn to third-party hardware and software industries to acquire their technology assets. In industries where technology disaggregation is the norm, what might otherwise be differentiating technology capabilities is readily diffused to the rest of the industry. Therefore, the adoption of readily available third-party technologies alone does not provide a meaningful, sustainable competitive advantage for service firms.

Product-based services, like other service sectors, also rely on third-parties for component technologies but they add value through architectural innovation. Hendersen and Clark observed that development efforts in component technology only result in incremental innovation as the established paradigm is reinforced, whereas efforts that involve architectural change result in more significant innovations. Apple and OnStar have created breakthrough products on the basis of architectural innovation. Meanwhile, the credit card industry's rollout of RFID is a component level development that reinforces existing business paradigms.

Two types of technology know-how are important in developing an architectural breakthrough. *Component technology know-how* is a working understanding of the physical parts of a technology (hardware or software). *Architectural know-how* is an understanding of how the component technologies and business concepts are linked together.

Other knowledge assets, while not necessarily involved in architectural innovation, can also be a source of competitive advantage. *Proprietary methodologies* like CompuCredit's credit scoring models enable firms to perform business functions better than their competitors. Proprietary methodologies are developed over time through

experience and experimentation. *Data-based know-how* is accumulated over time using technology to collect information regarding usage patterns. When used wisely, data-based know-how can be the basis for invaluable services to the customers and other stakeholders. Because of the strategic importance of knowledge assets to innovation, managers responsible for product development in a service company must be careful that established processes and culture do not cause the organization to dismiss ideas because they do not fit into the existing paradigm.

FUTURE WORK

The principles that I proposed in this paper require further work to substantiate:

- Additional research into how service firms use knowledge assets to create meaningful innovations is needed. Of particular interest would be a comparison of component vs. architectural efforts. Further studies of product-based services as well as pure service businesses (i.e., no delivery platform) could provide invaluable insight.

- While OnStar is an example of an architectural innovation, a follow-up study on how OnStar's patent activity correlates with its position in the industry (or perhaps GM's position in the automobile manufacturing industry) would be very meaningful in a few years, after the market has some time to mature.

- It would also be of great interest to study the anatomy of individual service firms and analyze how the unique knowledge assets of the firm might be reflected in the organizational architecture.

I began this endeavor thinking that services is a separate domain altogether and that the principles of innovation are different and more abstract. My research has taught me that there are more similarities than I had originally observed. Much of the work that has been done in product industries is very relevant to the service domain, and where there are inconsistencies, I believe that established product principles can be extended. This is not to say that new principles relevant only to service industries will not be found. There are some important nuances that can have significant implications for managers of innovation in service companies. We highlighted one subtlety in the pattern of

innovation in product-based services. Patterns of innovation in service industries appear to more be abstract, but the good work that has been done in the product domain has laid a solid foundation for future work in this field.

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