Smart Cards In Europe & The United States: Old World vs. New, and Which is Which?

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Abstract

This paper focuses on one specific form of information technology, the smart (chip) card. Smart cards involve a variety of issues of varying complexity and scope, as evidenced by the experiences of the countries who have employed the cards. However, the European acceptance of smart card technology is far greater than that of the United States. This paper examines the rapidly emerging and developing market for smart card applications, specifically in comparison to its use in Europe and United States. In this paper, the emphasis is on the various applications and market factors related to the use of these cards. Our discussion will focus primarily on smart card technology in the form of a credit card-sized mechanism. However, the technology could be applied to a wide variety of common items. These could potentially include a key chain, a decorative pin, a locket or a belt buckle. In fact, most anything found in a person's wallet could, and potentially will, be stored on a smart card including "driver's license, insurance information, credit cards, bank accounts", various other forms of identification. For this reason, IT students benefit from at least a rudimentary understanding of the potential impact and use of smart card technology.

Keywords: Smart card, Europe, technology, barriers, United States

1. INTRODUCTION

This paper examines the rapidly emerging and developing market for smart card applications, specifically in comparison to its use in Europe and United States. Smart cards involve a variety of issues of varying complexity and scope, as evidenced by the experiences of the countries who have employed the cards (Fancher 1996). Over the years, critics have said that smart cards were a technology in search of a solution, but it may be that the psychological obstacles are a greater deterrent to their use than the technical aspects (Flohr 1998). Many Europeans already have at least one smart card in their wallet (Muller 2000). Barriers to previous acceptance in the U.S. are also explored, as are the reasons why Europe has established a remarkable lead in its use of smart card technology, specifically when compared to the U.S.

Smart card technology is portable, secure and can access services via a variety of devices (Elliot 1999), as the card can essentially combined the power of a small microcomputer with the simplicity of a credit card (Theoharides 1997). Our discussion will focus primarily on smart card technology in the form of a credit card-sized mechanism. However, the technology could be applied to a wide variety of common items. These could potentially include a key chain, a decorative pin, a locket or a belt buckle. In fact, most anything found in a person's wallet could, and potentially will, be stored on a smart card (Whitford 1999) including "driver's license, insurance information, credit card and bank account [information, and] frequent flyer and frequent-stay [information]" and various other forms of identification (Whitford 1999, p.61). Smart cards and their related technologies are an emerging worldwide component of electronic commerce. In some countries, they are revolutionizing several aspects of everyday living, including aspects related to recreation, business, medical and even personal identification. We believe students of information technology can gain valuable insight into a variety of implications of the information age, including privacy, changing business practices (providing new insights into supply chain, market forces, corporate policies and knowledge management) and information management. In addition, smart cards have specific hardware and software implications. For all these reasons, IT students benefit from at least a rudimentary understanding of this technology.

2. BACKGROUND

The following are brief descriptions of the major types of traditionally-sized cards. They are intended to present a perspective of what a smart card represents.

- *Credit cards* are essentially electronically extended credit for making purchases (Cross 1996).
- *Debit card*, through the use of a personal identification number (PIN), allow users to access cash, typically at a bank or automatic tell machine (ATM) (Cross 1996).
- A *store value card* is an initial step towards a cashless society, as a fixed about of value is electronically placed on the card. Retailers can then swipe the card through a reader, which deducts the appropriate value from the card. In the case of a disposable card, when the value has been reduced to zero, the card is discarded. With a re-loadable version of a stored value card, additional value can be placed on the card with a reloading device, perhaps through an ATM (Cross 1996).
- An *information management card* can contain a variety of personal information, which is not necessarily related to consumer purchasing. Such information might include health information and emergency contact information (Cross 1996).
- A *loyalty card* accumulates points or credits towards some type of vendor reward (discount, products, services). Such a card facilitates the benefits of instant rewards to be redeemed at the point of sale (Cross 1996).
- *Multi-application cards* combine one or more of the functionalities of credit, debit, stored value, information management and/or loyalty cards. Smart cards are an example of a multi-application card (Cross 1996).

3. EVOLUTION OF SMART CARD

Theoretical work was patented beginning in 1968 (Shelfer 1999) but the technology necessary to support this innovative thinking was not available until 1976 (Husemann 1999). *Motorola* Semiconductor produced the first microchip for a smart card in 1977 while working in conjunction with *Bull*, the French computer company (Flohr 1998). *Bull* was the first company in the world to make major investments in the technology (Priisalu 1995). Table I presents an outline of the evolution of the smart card.

Table I. Evolution of the smart card

Year	Event
1968	2 German inventors patent combining plastic cards with micro chips
1970	Arimura invents & patents in Japan **
1974	Roland Moreno invents & patents in France **
1976	French DGT initiative, Bull (France) first licenses **
1980	First trials in 3 French cities **
1982	First U.S. trials in North Dakota & NJ **
1996	First university campus deployment of chip cards**

*Husemann 1999; **Shelfer 1999

The French had several pragmatic reasons to undertake research smart card technology. The 1970's was a period when France undertook a program aimed at the modernization of their national technology-based infrastructure (Priisalu 1995). The French banking association, Cartes Bancaires, was searching for a way to reduce bank fraud as criminals were illegally scanning traditional magnetic stripes, and then copying this data to counterfeit credit cards (Flohr 1998). Fraud rates did indeed drop after the cards were placed in service (Flohr 1998). Another motivation for the French, as well as other European countries, to investigate utilizing smart card technology is that Europe has historically experienced high transaction costs due to their high cost of telecommunications. Smart cards offer a cheaper, more efficient alternative, as most transactions can be processed offline (Priisalu 1995).

The first test of smart cards in France, however, were not initially successful because the cards themselves were too expensive and lacked sufficient quality. There was a lack of technical infrastructure to be utilized and integrate with the cards (Shelfer 1999). The cards were initially intended for purposes of identification, but their capability was quickly recognized by the State, as it expanded their use to include prepaid télécartes that would render coins in phone booths obsolete (Muller 2000) in the 1980's. An association of banks also issued chip-embedded cards to fight fraud (Muller 2000). France Télécom enabled Minitel "with smart card readers to enable online purchase of everything from opera tickets to train reservations, well before anyone had heard of the Internet" (Muller 2000, p.31).

Figure I presents a breakdown of the components of an electronic module, which serves as the 'top' layer of an embedded smart card processor chip. Security is increased and card size is minimized through the combining of all of the depicted elements into one integrated chip. Figure II depicts how this module fits into the overall architecture of a process-enabled smart card. (Depending on their intended capability, some chips may not include all three types of memory (ROM or Read Only Memory, NVM or Nonvolatile Memory, RAM or Random Access Memory). (Leung 1999).

Figure I. Architecture of Smart Card Electronic Module

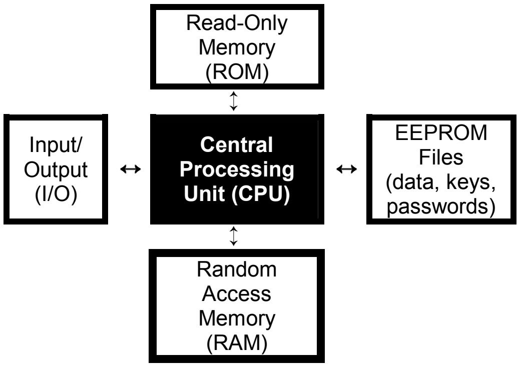

Figure II. Component Architecture of a Smart Card Processor

Electronic Module (Figure I)
↓
Integrated Circuit (IC) (silicon)
↓
Inserted Into Smart Card with epoxy

The International Organization For Standardization (http://www.iso.ch/) defines several specifications for smart card manufacture, which are depicted in Table II.

Table II. Some ISO Smart Card Specifications

ISO 7816-4	partially "defines file structures and layouts" *
ISO 7816-1	physical characteristics
ISO 7816-2	"contact location and dimension" **
ISO 7816-3	"electrical signals along with low-level transport" **
ISO 7816-4	"high-level application communication protocols" **

* Card Europe www.cardeurope.demon.co.uk/rep1.htm
** Husemann 1999, p.25

4. BASIC TYPES OF CARDS

Memory Cards Vs. True Smart Cards

Some of the sources used for this paper referred to any credit card-sized card with memory above and beyond that offered by traditional magnetic stripes (credit and debit cards) as 'smart cards'. Technically speaking, true smart cards as those that have an on-board embedded processor. The simplest form of a smart card is a memory card. Such a card is designed to securely store personal information. Its available memory is either 8Kb or 16Kb (Berinato 1998). (For purposes of comparison, traditional magnetic stripe-based cards can store approximately 200 bytes of information.) The storage on a memory card is nonvolatile memory and the card contains a relatively small amount of circuitry which is used for security (Fancher 1996). Such cards are sometimes referred to as synchronous cards (Husemann 1999). An example of this technology is simple prepaid cards, which transfer the electronic equivalent of cash to a vendor's "digital 'cash register'". This value can then be transferred to a traditional bank account (Fancher 1996). Europe's phone card was the predecessor of the smart card (Whitford 1999).

Synchronous cards are 'true' smart cards. They contain a processing chip, "short- and long-term memory cells" (Fancher 1996) and, possibility, special circuitry to "perform RSA public key encryption, signatures and verification" directly on the card (Berinato 1998, p.30). These include onboard data processing capacity with significantly more memory than their magnetic stripe-based card counterparts, enabling them to handle multiple functionalities (Flohr 1998). In addition, some such cards can have applications downloaded to them (sometime by the customer) without having to modify the card, any previously existing applications on the card or the applications being loaded (www.cardeurope.demon.co.uk/rep1.htm). These multi-application cards are more expensive than memory cards (Berinato 1998] and are sometimes referred to as 'white cards'. These downloadable applications can be in the form of Java-based applications, which are small and secure in nature.

Contact, contactless and 'combi' cards (those that have the capabilities of both contact and contactless cards) are similar to using a credit card to pay for a purpose at a store, as the standardized electrical contacts on the front of the card replace or serve in addition to a magnetic stripe on the back of a card (Fancher 1996). The card's integrated circuit is connected to the card via a contact plate on the card's surface. When placed in the reader, an electrical circuit is completed when connection is made between the reader and the contacts (located on a contact plate) on the card (www.cardeurope.demon.co.uk/rep1.htm). Standards help ensure that smart cards will be readable by any retailer who is equipped with a smart card reader (Cross 1996). The power necessary to retrieve, process and store information is supplied to the card by the reader (Fancher 1996).

For applications where the card needs to be read very quickly, such as when paying a highway toll fare, a relatively new incarnation of smart cards was developed. Referred to as a *contactless* version of a smart card, they first appeared in 1998 and presented quite a technical challenge. A contactless card does not contain any electrical contacts Instead, it uses a form of electrical coupling (www.cardeurope.demon.co.uk/rep1.htm). (Aside from the physical and technical issues of contactless cards, there are additional considerations for an application that utilizes such cards.) Whether contact-based or contactless, smart cards are able to read, write and process data. In some applications, associated transactions may need to be linked to a central organizational computer (Cross 1996).

Combi cards have a single processor chip, but it has both a contact and contactless interface. The chip offers this dual interface with a high level of security. The Smart Card Institute of America (www.scia.org) suggests that mass transit and banking will be among the first industries to realize the benefits offered by combi cards (Cagliostro). A hybrid of a combi card is one that is equipped with two processor chips. One chip is equipped with a contact-based reader interface, and the second with a contactless-based interface (Cagliostro).

Table III. Major Smart Card Configurations

	SMART CARDS	
Feature/Component	**Memory Card**	**Processor-Enabled Card**
Read Only Memory (ROM)	yes	yes
Random Access Memory (RAM)	no	yes
Microprocessor	no	yes
Contact/Contactless Interface	contact	contact, contactless or both
Example	phone card	multi-application cards

Comparison To Credit Cards/General Capabilities

Smart cards can store up 100 times more information than can be stored on a traditional credit card's magnetic stripe (Fancher 1996). In addition, magnetic stripe-based cards are not secure enough for today's electronically connected world, as these stripes can be easily compromised. They are easy to duplicate and would-be criminals can defeat the equipment associated with credit cards (Whitford 1999). Further, magnetic stripe-based card are intended for very limited applications (Cross 1996), but in contrast, the ability to support multiple applications is one of the main strengths of smart cards (Solomon 1999). Also, the data stored on smart cards can be protected by active data encryption and biometric identification (fingerprints, for example), and can be used to uniquely identify the authorized user. Finally, the cards themselves are difficult to duplicate (Reid 2000).

5. IMPACT OF SMART CARDS ON INDUSTRY

Many businesses have already begun to reexamine their business models and practices as a result of the Internet and, specifically, the World Wide Web. Smart cards have begun to bring together unlikely business partners, some who are competitors (some who are even fiercely competitive) and other from vastly different industries (Theoharides 1997). Partnerships are created that will benefit all parties, as incentives to purchase one good or service can be linked to incentives to purchase another firm's goods or services (Solomon 1999). In fact, such promotions can create some potentially creative, and lucrative partners (Cross 1996). Examples include travel-related relationships between a hotel chain, or airline and car-rental (Solomon 1999) and, in more general terms, "banks, retailers, telecommunications companies, hardware and software companies" (Cross 1996, p.34).

This trend toward partnering within and beyond a given industry is not only expected to continue, but to increase in frequency, as partnerships and convergences will be aided by smart card technologies. These businesses should be able to link marketing promotions with a minimal investment of a smart card reader, therefore avoiding the costly technological infrastructure that is common with many traditional forms of multi-firm promotions (Cross 1996). Such partnerships will offer cardholders excellent value, which will further encourage adoption of smart cards (Solomon 1999).

Smart card-based customer incentive (loyalty) programs have the potential to simplify such promotions and reduce costs associated with more traditional forms of discounts, such as coupons handling (Cross 1996). Such programs increases the ease with which consumers can participate (Cross 1996) and promotions can be adapted to potentially rapidly changing market conditions relatively quickly compared to traditional loyalty programs (Cross 1996). Smart card-based promotions also have the capability to support additional promotional benefits, such as free parking or other such services that would ultimately also recognize smart cards (Cross 1996).

6. EUROPE VS. UNITED STATES

There are several key factors that will greatly influence the relative success (or failure) of smart cards in the United States in the next few years. Among these are issues related to privacy, support for multiple applications and the cost of the related technology. Europe is regarded as the world leader in smart card development and deployment (Fletcher 1999). Of particular interest for this paper is that "Europe is leapfrogging the U.S. in some sectors that are at the heart of the technological revolution" (Muller 2000, p.28). There are several factors inherent in Europe's recent history, culture and demographics which have contributed to Europe's dominant use of smart card technology. In part, this is a result of Europe's general acceptance of government involvement in industry, its high level of regional market fragmentation, historically high telecommunications cost and high rates of credit card-related fraud.

The Smart Card Industry Association (www.scia.org) estimates that of the smart cards in use globally, 40% are in use in Europe (Husemann 1999). Table IV includes worldwide statistics that were gathered by Gemplus (www.gemplus.com), a global producer of smart cards www.cardshow.com/statistics/uk/gemplus.html).

Table IV. Worldwide Smart Cards In Use

Segment	1994 (millions of units)	2000 (millions of units)	Average Annual Growth
Phone cards	310	1,400	29%
GSM cards	9	50*	33%
Health cards	62	400*	36%
Bank & loyalty cards	20	500*	71%
Identification	1	400*	171%
Transport tickets	1	200*	142%
Pay TV cards	10	100*	47%
Games	1	500	182%
Meters	2	50	71%
Access control	-	-	-
Automatic dispensers	4	200	92%
Total	**420**	**3,800**	**44%**
* microprocessor cards			

It has been suggested that Europe is ahead of U.S. in its widespread adoption of smart cards due in part to the European's experience with alternative payments plans, including debit cards, prepaid transportation and telephone cards (Cross 1996). The French have been using phone cards since the 1970's (Whitford 1999). In 1997, the Dutch had issued more than one smart card (called Chipknip; knip is 'purse' in Dutch) for every two Dutchmen. The cards had 8Kb of chip memory (compared to the usual 200 byte magnetic strip found on a credit card) and can be used as both a debit card and electronic wallet. Eight million cards were issued by 1997 (Guyon 1997). In Holland, parking meters, newsstands, vending machines and pay telephones all accept smart cards (Guyon 1997). In the Russian city of Neftekamsk, smart cards have been reported to help in alleviating a shortage of cash through the honoring of the cards to allow factories to sell goods and pay factory employees in the town (Kutler 6/9/99). Without the system, purchases were declining and bartering was on the rise (Kutler 6/9/99).

7. EUROPEAN INFORMATION TECHNOLOGY INDUSTRIES

Of the top ten fastest growing European companies, five are information technology/Internet related (Muller 2000). *Europe Unlimited*, a Belgium-based research firm, recently reported that about 25% of Europe's 500 fastest growing companies are high tech in nature (Muller 2000). Two such companies, *Gemplus* (French smart card maker) and *ASG* (German smart card maker) (Muller 2000) manufacturer SIM (Subscriber Identity Modules) smart cards (Muller 2000). Gemplus supplies chips for IBM-branded smart card products, for example. Such cards are presently in all European mobile phone for the purpose of identifying and billing the appropriate person (Muller 2000). It is widely expected that when a new line of phones with Internet access becomes available, European consumers will be able to use these phones, together with their smart cards, to make secure purchases over the Internet (Muller 2000).

Three French companies produce about 70% of the world's supply of smart cards, a $12 billion business including Gemplus, Schlumberger and Bull (Muller 2000). In today's fast-paced wired world, such a lead may be insurmountable, as 'next-best competitors' can be left in the proverbial dust if they don't take advantage of major shifts in conducting business (Morrison, et al 1999). Many Frenchmen carry such smart cards (Muller 2000), which include data in special health conditions, adverse reactions to certain drugs (Theoharides 1997), blood type, allergies, permission for organ donations (Rogers 1996), currently treated conditions and physician's contact information (Fancher 1996). Telephones capable of reading multiple smart cards, are part of a "common technological base [which] will provide a greater opportunity for the banking industry to work with the telecommunications industry to offer joint services" (Kutler 11/4/98, p.1). Mobile banking is expected to assist banks in acquiring and retaining customers, as well improving its revenue generating (Kutler 11/4/98). Joachim Hoffmann, *Motorola's* director of mobile commerce business in Europe, the Middle East and Africa: "Personal mobile access to electronic commerce will speed up the rollout and adoption of smart cards" (Kutler 11/4/98, p.1). He went on to say that "this solution is the catalyst that will likely ignite the market and smash current industry forecasts" (Kutler 11/4/98, p.1).

Paris' transport authority, the French National Railways and several Parisian transport companies have been testing a replacement for the magnetic ticket system (Valenti 2000). One of the major advantages of the program is the use of automatic card readers at train stations (Valenti 2000). Such technology will also be intended to allow commuters to pay for taxi, newspaper and coffee (Valenti 2000). (While a trial of smart cards for mass transit failed in New York, but this has more to do with the study design than with the technology.) The cards can also contain memory that can be allocated for a variety of other purposes, including the paying of tolls, parking and telephone calls and vending machines, and the facilitating of banking services (Valenti 2000). Passes are marketed by Modeus, a Paris-based "consortium of banks, Postal Service and the national railways" (Valenti 2000, p.12). In 1997, 19.5% of French households conducted some of their financial transacting on-line (Bank Systems & Technology 1997). Smart card readers were used in more than 500,000 French households in 1997 (Bank Systems & Technology 1997).

Many industries have their own special needs and requirements for what they need from a smart card (Reid 2000) Standard development is underway, however. The Secure Electronic Transactions (SET) protocol is expected to become the standard for the electronic wallet. It was developed by SETco, which is an organization co-founded by *Visa* and *MasterCard* (Schacklett 2000). SET is also an essential electronic commerce component of security in France (Kutler October 1999). Electronic wallets and their applications are reasonably complex, however, and many details are still not set (Schacklett 2000). In anticipation of these issues eventually being settled, U.S. financial institutions, as well as other industries, are currently positioning their business practices to be "potential brokers of electronic wallet payment processing and distribution, with the potential of collecting fees for [the] service" (Schacklett 2000, p.15). Credit unions have developed small, closed systems of vendors who accept the electronic wallet, while the union acts as a "clearinghouse and distributor of transactions" (Schacklett 2000, p.15).

On the vendor side, a further barrier has been that the technology associated with smart cards (including readers and the card, themselves) have historically been expensive. Sven Hammar, president of *Celo Communications* (data encryption specialists) noted that "smart cards offer the best way to achieve security and non-repudiation for on-line transactions, but until now the readers were expensive, difficult to install and vulnerable to theft of personal identification numbers by hackers" (Kutler October 1999, p.19). The theft of PINs was made possible because of the necessary keyboard interface that was needed to input the PIN (Kutler October 1999). The readers were also slow and relatively large (Kutler October 1999). Buy-in by American vendors requires the cards to be reliable, and the readers to be fast and reliable, all at a cost-effective pricing levels (Reid 2000). Hardware and software must have standardized protocols (Reid 2000). There is a strong need for security when transacting business and smart card supports various encryption technologies, combining the convenience of using a credit card on the Web with the security that consumers, vendors and financial institutions demand (Schacklett 2000).

College campuses are essentially a 'closed' system, which also makes for a vital, emerging opportunity for smart card technology. The notion of using cards for student identification is not new, but integrating this function with "back-office database management systems is" (Shelfer 1999, p.426). Such data is intended to assist administrators in their operational and strategic decision-making (Shelfer 1999) and improve operations through

- Reductions in paper and cash-handling, and associated reduction in necessary manpower.
- Reduced risk of robbery with reduction of necessary cash.
- Reduced overhead through automation and integration of services.
- Reduced costs through redeployment of campus services, such as redeploying campus transportation routes on large campuses.
- Revenue enhancement through the ability to implement, monitor and modify a mix of merchant services and loyalty programs

8. EMERGING AND FUTURE WORLDWIDE POTENTIAL FOR SMART CARD APPLICATIONS

A spokesman for smart card provider, Gemplus, stated that "the potential applications [for smart cards] are innumerable and provide almost total security and reliability of identification" (Muller 2000, p.31). General services are expected to ultimately include "Internet currency, money transfers within or between systems, and repositories for protected, readily transferable information," including financial, medical, security-related and military (Theoharides 1997, p.13). Eventually, some predict all plastic cards (credit, debit, ATM, personal identification, loyalty card) will someday "meld into one universal, multifunctional smart card" (Schacklett 2000, p.14). As the world gets increasingly more connected, the need for reliable identification of participating individuals is expected to rise as well (Jain, et al, 2000). Prakash Panjwani, director of the wireless market for Certicom (a provider of encryption technology), noted that "a lot of carriers are trying to get into the [wireless data] market to show that it is possible." (Carroll 2000, p.40) Panjwani goes on to suggest that in time, after e-commerce has become more prevalent, security will prove to be the most important issue (Carroll 2000). Many security instruments can be ported from PC's (of which many were created by American and Canadian firms) to wireless-based tasks (Valenti 2000).

Although the initial cost associated with utilizing smart cards is higher than those associated with the handling of cash or credit card transactions, smart cards offer the costs per transaction is lower with smart cards (Fancher 1996). The airline industry offers a service that could potentially realize tremendous benefits for both the airlines and their passengers. Passengers could use a computer terminal to reserve a seat on a plane and rent a car, and then have those reservations stored on their smart card. When they arrive at the airport, they would simply swipe their card through a reader and board the plane. Upon arrival, they might swipe their card through a rent-a-car machine, which would read their card, verify their reservation and then present them with the keys. A similar procedure for creating a hotel reservation, and then checking in, is also possible. Such processes would generate little, if any, paperwork, as an electronic recording of all associated charges would be stored on the appropriate vendor's computer and on the consumer's smart card (Proffitt 1996).

Gemplus is supplying Mendoza, a province of Argentina (http://www.cardshow.com/guide/card/gemplus.html), with smart card-based drivers licenses. These high-tech licenses include the complete driving record of the driver and any unpaid traffic fines. The Metropolitan Transportation Authority's EZPass system is designed to quicken the paying of tolls as motorists pass through the tolls. A specific example is that toll rates could be time-based, as different rates could be charged, depending on the day of the week and/or time of day, for individual roads (Woolnough 1994). The healthcare industry also could prove fertile ground for the use of smart card-based technology. The industry continues to experience a technological overhaul, as electronic data management becomes more widespread and sophisticated. Smart cards have the potential to support all the four major levels of telemedicine (Rooney 1999).

The use of electronic communications for the advancement of healthcare, however, does not come without some serious questions of ethnics, privacy and legality. Data accessibility and confidentiality associated with the electronic storage and distribution of personal information are major concerns for both patients and healthcare providers. Smart cards could also have an impact in the fulfillment of drug prescriptions. Prescriptions to be filled could be loaded onto a smart card at the physician's office, and then the patient could take their card to their local pharmacy where it would be swiped in the pharmacist's reader, indicating the prescribing physician's information, the medication and proper dosage. With proper encryption, prescriptions could also sent electronically to the pharmacy from the physician's office. Again, the patient could have their card swept at the pharmacy for fulfillment. In addition, payment terms could also be arranged through the card.

Calculations related to currency exchange can be handled by smart cards, and as a result, they could easily replace large portions of the related infrastructure, including concepts like traveler's checks (Cross 1996). *Motorola*, in anticipation of taking advantage of its expertise in radio frequency technology and microprocessor technology, both of which would support multiple smart card applications and provide high level of security, created a new division a few years back to develop this stuff: Smart Card Systems Business (SSB) (Bank Systems & Technology 1997). *Motorola* has been making semiconductors (chips on smart cards) since the late 1970's, and also offers the cards themselves, as well as the card readers (Block 1997).

Smart cards offer enormous potential for micro-marketing through data mining. Banks can make money from the information that is being gathered from every smart card transaction in the reader of a retailers; data is collected about both the buyer and the purchase itself; many marketers will pay for such valuable information and there will be increasing pressures on banks to sort out revenue-generation versus privacy issues (Guyon 1997).

9. CONCLUSIONS

The following are considered critical for U.S. acceptance of smart cards:

- support of multi-applications.
- consumer confidence.
- card is secure in event of lost or stolen and financial loss is minimized.

We believe one of smart card most far reaching implication is the associated research and possible improvements in economies of scale, reliability accuracy in biometrics; also introduces concept to American consumers. The technology is available. Now we wait for the business models, and consumers, to catch up (Solomon 1999).

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