Reengineering Money:  
The Mondex Stored Value Card and Beyond

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Abstract

Electronic cash systems, such as Mondex, seek to re-engineer cash payments. While the use of cash imposes numerous invisible costs on the economy, numerous security and consumer acceptance issues prevent its immediate replacement. After analyzing the economics of the proposed Mondex electronic cash system, including suggesting sources of gain for multiple channel members, we conclude that the major challenges in the global implementation of electronic currency will be establishing the proper incentives for channel members, regulatory barriers, and gaining critical mass of consumer and merchant acceptance rather than difficulties with technology or network security.

1. Introduction

"Mondex can be used for everything from buying a hamburger to paying the paper boy."

Tim Jones, Mondex CEO

As a store of value and means of exchange, cash is king. At first examination, it seems the least complicated, least costly, and most universal method of payment recognized by the 1990s economy, despite having existed for thousands of years. Processing cost for cash payments appears (somewhat deceptively) to be quite low compared to that of checks, credit cards, or direct billing on account. Cash is recognized as a form of payment in many business operations that accept no other, and many person-to-person obligations are settled with cash. In addition, cash has a very quick (if not infallible) "speed of authorization." It requires only a fraction of a second to recognize a bill, and although it may be a challenge to determine whether a given $100 bill is genuine, it is certainly more difficult to forge a U.S. Treasury note than to write a check on a defunct account. Cash is convenient and easy to use, and its adoption is absolutely universal. In particular, small transactions are most easily accomplished with cash, and this ease translates into an impressive market share for these small transactions: it is estimated that, of the annual $360 billion in U.S. cash transactions, 75% ($270 billion) is made up of tiny transactions under $2 each, in obviously vast quantities. [UK figures are similar: £7.6 billion in cash transactions under £5 comprise over 60% of all cash transactions.]¹

1.1. Why Reengineer Cash?

When cash works, it works well. To reengineer cash, we would have to replace the familiar form of banknotes and coins with a new technology while retaining—or enhancing—cash's old functions of low transactions costs, transaction speed, partial anonymity, and high acceptance. Why replace King Cash? Four major reasons exist: reducing handling costs, improving ease of use, eliminating high costs of infrastructural support, and enabling new avenues for distribution. First, the actual handling costs of cash—including costs of securing cash from dishonest employees, opportunity costs of foregone interest, rolling coins, and so forth—may significantly exceed costs of checks or of credit cards, which provide easy methods of security and float management at the expense of authorization time and post-transaction processing. NatWest Bank estimates that these costs of handling cash within the UK add up to a staggering £4.5 billion annually, £2 billion of which is borne by customers. In addition, the anonymous nature of cash (especially "small, unmarked bills") leads to an enormous problem with theft, as the thief can anticipate easily respending the cash with low probability that his use of stolen bills will lead to his capture. Just this desire to protect against theft has led to the proposed introduction of Visa stored value cards, a disposable card which can be converted into cash at any ATM but which is valueless and potentially cancelable and refundable to the rightful owner without the accompanying PIN.²

¹ Both U.S. and UK figures are from Mondex, "Towards Global Electronic Cash," Tandem Finance Industry Forum (Orlando, FL); January 19, 1992.

Second, while cash is as easy to use in the United Kingdom as in the United States, cash varies from country to country. Cash as a global concept, rather than a single currency, is really a network of dozens of currencies, which are mutually exchangeable only in a small fraction of the establishments that accept some form of cash. In addition, the concept of "exact change," a prerequisite for trading with many 20th-century vending machines, occurs only with cash. Any traveler who's experienced the frustration of holding 90p in coins and a $1 bill and attempting to purchase two 95¢ sodas from an airport vending machine that demands exact change knows the problem: cash is not infinitely divisible, nor does having "enough cash" guarantee being able to complete a transaction. Coca-Cola estimates that 20-25% of potential sales are lost by not being able to match the desire to purchase its product with the means to do so; exact change comprises a large percentage of this "lack of means."

Third, the indirect costs of maintaining the infrastructure necessary to support widespread use of cash are considerable. Check-cashing establishments and armored trucks, for example, provide no social value other than the dispensing and protection of cash. Although ATMs offer information about a cardholder's account in addition to dispensing bills, the most common transaction at an ATM is the withdrawal of a small amount of cash—necessitating not only the use of a complex piece of electronic machinery but also time spent waiting in line at 5:00 on Friday afternoon. Vending machines set up to process coins and bills need to be periodically emptied (and restocked with change, if frustrated consumers are to be avoided.) Some businesses are net producers of change, others net users of it: physical transport of these pieces of metal from producers to users consumes time and energy without creating any new products. In addition, changing prices of vended products can be accomplished dynamically but only through the use of a complex piece of electronic machinery. Most people are frustrated with how long it takes to change a vending machine, and some time spent waiting in line at 5:00 on Friday afternoon. Vending machines need to be periodically emptied (and restocked with change, if frustrated consumers are to be avoided.)

Lastly, the change in cash payment from a physical transfer to a pure information transfer will support cash payment for services marketed electronically. Although Mondex is targeted at existing uses of cash, it is this still-undeveloped market that provides the impetus for most of the other proposed electronic cash systems.

1.2. Potential Benefits from Reengineering Cash

An ideally designed system of electronic cash offers enormous potential benefits to consumers and merchants, as described in BusinessWeek [1995]. Consumers can clearly save time in transactions by using a card rather than fumbling for change, and by omitting those twice-weekly trips to the ATM. Person-to-person debts could be quickly settled by direct transfer. An automatic record of all cash expenditures could be captured in real time and later analyzed, either for reimbursement of expenses or for analysis of spending patterns, much as some of today's premium credit cards categorize expenses on a yearly basis.

Merchants—especially vending machine operators—can capture sales that previously couldn't be completed. Revenues would be instantaneously transferable from a card or electronic till to a bank account, leading not only to increased interest revenues on deposits but also a greatly reduced supply of cash on hand and thus a corresponding reduction in risk of theft.

1.3. Structure of Mondex in National Markets

A Mondex originator creates electronic cash units, in effect, serving in the role of creator of electronic units of a given nation's currency. The Mondex system envisions only one originator per currency, although this originator may be owned cooperatively by a number of shareholders. A Mondex issuer, of which there could potentially be many in each nation, issues cards to customers, distributing and reselling the stored value created by the originators. The local originator thus sells electronic currency units in large quantities to issuing banks, in exchange for traditional currency—much as American Express issues travelers' checks to banks today. The Mondex issuer then distributes electronic units to customers, again in exchange for traditional currency, again much like individuals' purchasing travelers' checks at a bank. The consumers then use the electronic units with merchants, transfer them to other consumers, and so forth. When the electronic units leave circulation to return to the banking system, they are exchanged by the issuing banks for physical currency units. [The flow of value is illustrated in Figure 1.] In view of this 1-for-1 exchange, merchants and consumers can view electronic units and physical units to be equivalent in value.

While Mondex is not the only company testing an electronic cash system, it does have the most thoroughly developed set of business contacts through its participating banks. NatWest Bank U.K. and Midland Bank hold the U.K. franchise and are U.K. shareholders; they will be global founders in Mondex International when it is formed. Bank of Scotland is a sub-franchise holder from Mondex U.K. The process of franchising regional rights for Mondex has also already begun. Royal Bank of Canada and Canadian Imperial Bank of Commerce (in partnership with Bell Canada) plan a 1996 pilot program.3 The Hongkong and Shanghai Banking Corporation Limited acquired Mondex franchise rights.

and options in the Far East, including Hong Kong, China, India, Indonesia, Macau, Philippines, Singapore, and Thailand.4

The originator of the electronic cash that drives the system can also retain some portion of the benefits without necessarily increasing costs to either consumer or merchant, by taking advantage of the float created by Mondex cash. Much as the issuer of a traveler’s check today has free use of the money the check represents until the check is actually redeemed, the originator of “electronic dollars” may (depending on the design of the system) have free use of the real dollars exchanged for them until the electronic dollars are returned for redemption. This process potentially can take forever, as recipients of Mondex dollars (or pounds) can respend them instead of redeeming them. For purposes of illustration, the value of the “float” on the aforementioned $270 billion of less-than-$2 transactions, assuming an 8% risk-free return and an average length of float of two weeks, is $831 million per year. The originator earns interest on the float (in effect, a rental fee for the electronic units) during the time these electronic units are in circulation among consumers. When the electronic units are returned, the originator redeems the electronic units for physical units, completing the cycle and ending the float. In addition to gaining the interest from this float, the electronic cash organizer can potentially negotiate licensing revenues from banks authorized to issue electronic money.

Banks participating in the electronic cash network, charged both with clearing transactions and with “dispensing” electronic cash, can realize both offensive and defensive strategic benefits. By offering such a service when competitors do not, a bank can differentiate itself, leading to a gain in market share (competitive advantage); conversely, offering such services in parallel with competitors guards against share loss even when no advantage is forthcoming (strategic necessity). As will be seen, future entrants in banking will likely render electronic cash services a strategic necessity even if no current banks force the issue.

1.4. Factors Affecting Success

The key issues affecting success of a commercial electronic cash system are not simply whether the benefits from the product will exceed the costs of its creation assuming that it is adopted, but rather issues of channel coordination, consumer acceptance, and merchant acceptance. The feasibility of the initial business case rests on gaining a critical mass of consumer and merchant acceptance. Initial data on consumers’ willingness to adopt this technology from a market-research interview environment is good: The vast majority of consumers surveyed responded that they would be “likely” or “very likely” to apply for Mondex—twice as many as for U.K. debit card products.5

Data from a live test-market environment are expected to be forthcoming from Mondex’s July 1995 roll-out in Swindon, a UK city of population 190,000. Close to 1,000 merchants—including McDonald’s, Sears, British Petroleum, Laura Ashley, Sainsbury’s, Post Office counters, Thomas Cook Travel, and Ladbroke’s betting parlours—participated in this test market without any compensation from Mondex other than experience gained. Although Mondex covered all costs from this test, the eventual long-term allocation of benefits among the originator, the member issuers, merchants, and customers will depend crucially on strategic geometry, market alternatives, and the structure of competition at the various levels of the channel. The ultimate economic success of the system, from the perspective of Mondex International, will thus depend upon channel power and considerations that regulators and central bankers have not yet formally addressed.

When Alan Blinder, Vice Chairman of the Federal Reserve Board, was asked about his views on digital cash as recently as February 1995, his response was, “Digital what?” [BusinessWeek, 1995].

2. Review of Mondex Operations

From the perspective of users (that is, consumers and merchants) Mondex looks like a credit or debit card and operates like cash. Rather than visit an ATM to retrieve physical cash, a Mondex user places cash value on his or her Mondex card (powered by a specialized Hitachi H8/310 series microprocessor) by transferring money from an identifiable bank account; these transfers may be done either at a bank or by using the special hardware of a Mondex-equipped telephone. Once the card carries a cash balance, the user can present the card as a form of payment at a Mondex-accepting merchant, with the amount of the purchase automatically transferred from the card balance to the Mondex till of the merchant, from which it can be uploaded to the merchant’s bank. Mondex transactions of this type are entirely “off-line”: at the time of transaction, balances are shifted from one card to another without waiting for a verification from a central database. This off line status allows transactions for small amounts of money to be made as quickly as with cash, if not quicker. These benefits led to Mondex being voted the “Most Innovative Smart Card Accomplishment of the Year” at the 1994 European Smart Card Applications and Technology Conference in Helsinki.

Once transferred to a card, each Mondex cash unit is totally interchangeable with any other (even more so than cash, because Mondex currency does not bear serial

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5 Mondex Head of Global Sales, private interview, March 1995.
numbers like physical bills), making the user anonymous for all practical purposes if desired. Detailed central accounting of individualized transactions is neither necessary nor possible, facilitating speed of payment and keeping costs low. Individuals’ requirements for personal record-keeping are handled by an “electronic wallet” containing a chip, which could theoretically record thousands of transactions for reimbursement or budget analysis. It should be noted that this decentralized record-keeping leaves the onus on the buyer to prove payment (much like purchases made with cash). Individuals’ records are as secure as the individual desires; the card can be locked, using a PIN, to prevent unauthorized withdrawals or snooping. Thus, while the value on the card can be conveniently accessed without a PIN during the normal course of a transaction, the consumer can also lock the card when not actively using it, protecting large amounts of stored value from theft.

The Mondex vision includes, in addition to replacing cash for almost 100% of $2-and-under transactions, a bid to replace a sizable percentage of small- and medium-sized cash and check transactions between individuals. One special feature of Mondex that differs from a traditional credit or debit card, for example, is that value can be transferred from card to card. Before Mondex, physical cash was the only medium of exchange that could instantly effect such a transfer. Mondex-equipped telephones, a component of the system necessary for the “refueling” of cards from bank accounts, offer public access to this technology even to two walletless individuals. Every public phone would conceivably double as an ATM. As person-to-person credit and debit cards have yet to be introduced, Mondex’s opportunities in this market are potentially great.

2.1. Global Structure of Mondex

Mondex International itself is a franchising organization, a joint venture among numerous banks including all current issuers, continually updating and maintaining new technology, analyzing system security, and defining software standards to allow Mondex cards to recognize various electronic currency units. This central Mondex authority licenses the right to a local Mondex originator in each country to issue Mondex-dollars (M$), Mondex-pounds (ME), and so forth. To anyone participating in the Mondex system, these electronic currency units are, for all intents and purposes, “real money.” Although the Mondex system does not directly convert one currency to another, value denominated in up to five currencies can be stored in separate “pockets” on a single card. Value on a Mondex card can, of course, be exchanged at a bank for physical cash, if desired. In addition to its role as a franchisor, Mondex International is responsible for global management of the Mondex brand.

As noted above, detailed accounting of the movement of individual units of electronic currency through tracking individual consumer transactions is neither possible nor necessary. Similarly, detailed accounting of the issuing source of electronic currency is not necessary, provided that (1) the issuer does not issue electronic units without collecting physical currency (or equivalent value), and (2) the electronic monetary system is closed, e.g., no “counterfeiting” of electronic money occurs, and electronic dollars are “destroyed” only when exchanged for physical dollars. Establishing this accountability in money creation and destruction may prove to be the greatest security issue of all.

2.2. Security Issues

The specifications for accepting Mondex transactions are public documents, designed to encourage third-party development of complementary hardware and software, but the specific cryptographic techniques for validating individual cards are understandably kept private for security reasons. While 100% off-line authorization ensures speed and cuts transactions costs, such a verification system makes the usual security questions even more critical: how do we know a Mondex card is genuine before accepting money from it, and how do we know that the electronic dollars we’re receiving are not counterfeit? And if these dollars should turn out to be counterfeit, who is liable for their replacement or loss of value? Such concerns can be addressed in two ways: through cryptography to deter outsiders from breaking into the system and through properly designed channel incentives to keep insiders honest.

2.2.1. Keeping Intruders Out: Deterring Counterfeiting. The question of “is this a legitimate card?” is more difficult to answer for Mondex cards than for traditional smart debit or credit cards, which are uniquely identified by a number which must be tied at all times to existing customer accounts, which are subject to on-line authorization, and which can be effectively canceled by instructing the central database to withhold this authorization. The offline nature of the Mondex system precludes real-time card cancellation and on-line authorization; thus, every card must be able to recognize real Mondex money and distinguish it from counterfeit. To address this challenge, the current Mondex security plan uses a robust form of public key encryption to allow each card to swear to each potential acceptor, “I am an authorized card, with authentic value stored on me.” Neither of the parties needs to demonstrate who he is, or which bank issued the card or provided the value. Each party need demonstrate only that their cards came from

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6 Companies working to develop Mondex hardware (such as smart telephones, electronic wallets, and multicurrency cards) and software (for network control, personal budget analysis, and enhanced security) include AT&T, BT, Hitachi, and Panasonic.
somebody who's been approved by Mondex International to issue them, and that their electronic cash is genuine.

The question of "Is the money that I'm receiving real?" might be difficult to answer on a cryptographic level, but may prove to be less important to consumers (and more important to central bankers) than originally thought. Bad Mondex currency units, should they manage to get into circulation by some cryptographic means not yet envisioned, would by definition (and necessity) be perfect counterfeits: in the absence of serial numbers, all M$ units that pass the extensive cryptographic screening engendered by the card-and-wallet system are perfect substitutes. Although it might be detectable that counterfeit units have entered the system if the aggregate quantity of M$ or M& exceeds those created by the local originator, the individual counterfeit units could not be distinguished from legitimate units in any way. While this poses a significant cryptography problem to prevent counterfeiting, the after-the-fact indistinguishability of counterfeit M$ from legitimate M$ does have a silver lining: a receiver of M$ need not worry about whether the money he or she is receiving will be honored by the issuing bank (provided that counterfeiting is not so extensive that the issuing bank fails). Consumer and merchant acceptance is thus potentially bolstered by the same anonymity-of-units that gives fits to cryptographers (and, by extension, to issuing banks and governments).

2.2.2. Keeping Insiders Honest. We suspect that the principal threats to the integrity of the Mondex monetary system come not from the technological side (teen-age hackers with advanced degrees in cryptography using soldering irons and supercomputers in their garages) but from rogue issuers or originators (or rogue employees of honest issuers or originators.) Had his bank been a Mondex originator, for example, it would have been no more difficult, in theory, for Ronnie Ewton to cover his embezzlement (or, for that matter, Nick Leeson to cover his trading losses) by covertly releasing M$ into circulation than by forging internal memos. The problem of a rogue issuer or originator arises when we consider the long-term effect of these M$ on the Mondex monetary system. Like any monetary system, an originator's injection of extra currency units into circulation without receiving any consideration for them, if undetected, causes inflation and devaluation of the existing legitimate units. [If detected, an offsetting "open-market operation" can be made by the currency's central bank, maintaining the integrity of the electronic currency unit, and the originator billed for the appropriate amount.] Although the legal interpretation of who holds liability for losses from counterfeit electronic money has not yet been formed, the willingness of originators to honor all electronic units as genuine—and to redeem them for cash—is critical to public confidence in an electronic cash system.

3. Unresolved Issues

Issues yet to be resolved include regulating the issuance of electronic currency, pricing strategies, implications for other forms of electronic currency money, and broader issues with virtual money.

3.1. Regulating Currency Creation

In addition to destroying the integrity of its own electronic monetary system, a serious breach of Mondex security might compromise the physical currency upon which the electronic form is based. National central banks are thus expected to be interested in (and, potentially, skeptical of) Mondex, and issues of monetary regulation are still largely unresolved. In addition to protecting the integrity of their country's currency, central banks may feel threatened by Mondex's ability to substitute in everyday transactions for paper money—in effect, competing with and reducing the government's ability to earn the float from selling currency to banks. Governments losing this ability to manufacture small pieces of paper and bits of metal and call it "money" (a process known as "seignorage") may experience a revenue reduction, even as the world as a whole captures enormous benefits by eliminating ten billion pocketfuls of loose change. While society might embrace electronic money enthusiastically, there is thus no assurance that governments will be accommodating in allowing the free market to determine operating format, or in surrendering the right to perform seignorage.

3.2. Pricing Mondex

While many different Mondex fee structures suggest themselves, the method that will be used for Mondex has yet to be finalized. Opportunities to charge consumers include outright sales of cards or wallets; a monthly rental fee for the use of a card or wallet; a fee for each transfer between the card and an authorized bank account; or a small discount on the exchange between money and e-money (and vice-versa), similar to a retail foreign-exchange transaction. Opportunities for collecting fees from merchants are similar, for example, the option to charge a fee to deposit money from a Mondex card to a traditional bank account (similar to a back-end load on a mutual fund). Redemption of electronic cash for physical cash will be a service vital to merchants but seldom used by individuals, and thus a way to charge different prices to these two groups. Much as Saturday-night stayover requirements separate business and leisure travelers, allowing the latter to enjoy low airline fares while keeping average revenue high, redemption fees can

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separate merchants from individuals to collect revenue without discouraging individuals' adoption of the new technology.

Despite this range of opportunities, the operational economics of Mondex remain significantly less publicized than the cryptographic technology or the logistics of payment flow. Fundamental questions of market research remain: for example, will consumers actually pay to use Mondex, and if so, how much? Experience with electronic home banking has not been encouraging (and has been downright painful to banks' bottom lines) while experience with travelers' checks has been both encouraging and profitable. Mondex's Canadian partners have suggested that a monthly rental fee of $1.25 to $3 would cover both a Mondex card and a keychain-carried balance reader.\(^8\) We don't yet know whether merchants will be willing to pay for offering or using this form of payment. Again, U.S. experience with debit card acceptance has not been encouraging, although U.S. and UK experiences differ. As a hybrid between the electronic banking and travelers' checks, Mondex acceptance remains uncertain. Results from the Swindon experiment that began in July 1995 are eagerly awaited to answer these and other important questions about adoption of this technology, including basic issues of consumer and merchant acceptance.

Issues such as "Will consumers actually accept this form of currency in lieu of a paycheck?" and "will merchants actually be willing to hand over hard goods for no physically apparent compensation, without even a signed paper charge slip to back them up?" cannot be resolved by modeling but will require actual experience.

3.3. Extensions to Other Forms of Electronic Cash

The concept of virtual money as a store of value is not new, nor necessarily high-tech. A greenback is not the same as the goods or services for which it can be traded. The value of the plowing services, fertilizer production, and eventually ox-tail soup represented by an ox can be equated to the value of a stack of dollar bills, but the nature of the two assets are fundamentally different. (Economists would point out that the technical difference is that the value of an ox lies in production, whereas the value of a dollar lies in exchange.) Lighting a cigar with a $100 check is not the same as doing the same with a $100 bill; neither destroys value in the same way as does shooting (or, for that matter, cooking) an ox. Paper money thus represents virtual value the same way that Mondex represents virtual paper money. By disintermediating the clumsy paper and metal representations of value, electronic money promises to reduce the frictional costs of exchange.

Other forms of virtual money that are "almost, but not quite" cash—ATM cards, credit cards, charge cards, phonecards, Washington D.C. Metro cards, winning racetrack tickets, certified checks, irrevocable letters of credit, bearer bonds, and so forth—are part of the daily lives of millions who nonetheless continue to use exact change at soda machines. Debit cards, especially, qualify as electronic virtual money in that once an item is purchased, the consumer need do nothing else (not even pay a monthly statement). In Europe, payment systems such as Carte Bleue or Carte Bancaire offer a noncash hybrid, employing PIN-based service and retroactive billing with a chip-based card. Operational costs of debit and prepaid chip cards are significant, however; break-even transaction size for magnetic-strip debit cards is $20, for hybrid chip cards, $15. Such transaction economics make these media viable only for the upper 20% of transactions, leaving a large unserved market segment at the $10 and under level.\(^9\)

Some new forms of virtual money have been proposed as means of payment for the Internet, an environment where value can be exchanged but not easily paid for. On the Internet, the required physical presence just isn't there for exchange of cash and the ability of individuals to accept credit cards has not, until recently, been readily available. First Virtual Holdings [http://www.fv.com] has begun to address the last problem by making a limited form of Visa/MasterCard acceptance available to anyone selling an information product—regardless of age, time in business, or creditworthiness—who's willing to pay a one-time $10 fee plus 2% of each transaction, with proceeds cleared 100% electronically into a pre-established bank account.

DigiCash by [http://www.digicash.com], a Netherlands-based firm headed by cryptographer and noted electronic privacy advocate David Chaum, is testing a conceptual payment medium called ecash, an authenticated system designed to handle payments of very small amounts while offering near-total anonymity, although perhaps at the cost of security problems and slow response. Although plans to use Mondex technology over the Internet through World Wide Web [http://www.Mondex.com/Mondex/home.htm] are in development, the Swindon trial did not incorporate this feature.

3.4. Broader Issues with Virtual Money

One beauty of cash is the ability to purchase a 50¢ newspaper while walking by the newsstand without slowing down. The instantaneous speed of use of two quarters (if not fifty pennies) is difficult to equal. The value of this convenience to consumers, however, varies

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\(^9\) Transaction time also becomes an issue: debit cards require 7-8 seconds to complete a transaction, compared to 12 for cash and 36 seconds for a traditional check. Initial tests of Mondex indicate that a transaction can be completed in under 3 seconds [Mondex Head of Global Sales, private interview, March 1995].
significantly with the nature of both the item purchased and the circumstances of purchase. Physical purchases in person (as in our newsstand example) impose great time pressure for rapid authorization, as waiting in person is also quite noticeably annoying after a few seconds. On the other hand, purchases of physical goods remotely (whether on-line or via phone or fax) provide ample time to verify customer payment validity at very low cost without inconveniencing the customer. The merchant, bound by the relatively clumsy technology of physical delivery of the goods, has ample time to check the customers’ legitimacy before giving up physical control over the goods. The few minutes required for a fully-automated inventory system to select the correct item, pack it in a box, address the Federal Express airbill, and ready the package for shipping is more than sufficient to verify a credit card even using techniques that would be considered unacceptably slow by on-line or in-person customers waiting for an authorization in real time.

At the other extreme, on-line purchase of low-value on-line services imposes the greatest need for immediate authorization, not only because the user is excruciatingly aware of fractional-second delays in an on-line environment but because once the service is delivered, fraud detection after the fact becomes irrelevant—the information provided is impossible to reclaim, and the amount owed is not large enough to justify the cost of legal recovery actions.

The importance of total cost of using a particular payment system, made up of all of the transactions costs involved, also varies with the nature of the use. For low-value off-line transactions, the direct costs of positive and negative authorizations can be problematic if either requires on-line inquiry; as a percentage of the value of the transaction, the cost to the merchant of quick verification is prohibitive; the wait for slow verification, intolerable. For on-line interactive exchanges, however, a low-cost, time-intensive authorization method can begin as part of the login procedure and be complete as soon as the customer finalizes the order amount. Costs of security are also an issue; although cash is vulnerable to being stolen and pocketed (unlike most oxen), the difficulty of counterfeiting suggests that fraudulent transactions are fairly difficult to accomplish with electronic cash. Costs (and benefits) of being anonymous in a transaction also sway consumers’ choice of payment methods: for some transactions (such as membership in the highest tiers of frequent flyer programs) it is to the consumer’s benefit to be identified, whereas for others (Jenny Craig sneaking into McDonald’s to buy a Big Mac and french fries) the consumer may wish to remain untraceable.

The prospect of widely accepted electronic cash affects the ease of entry into traditional financial services markets as well as into electronic commerce. Given that withdrawals and deposits can now be made via telephone, the last reason for physical banking presence will vanish; no longer will a “bank” require investments in brick-and-mortar branches. The structure of account management and such mundane tasks as account administration, check clearing, and transaction processing can be outsourced; ATM privileges for customers can be provided through membership in one or more reciprocal networks; the occasional need for face-to-face sessions can be handled in nonbank buildings, much as many in-person mortgage applications are today processed in the customer’s home or office. When the only essential value-added of a bank stems from its effectiveness in marketing and information management, potential entrants with these skills may find the last traditional barriers to entry in banking erased.

3.5. Out on a Limb: Preliminary Assessment and Predictions

Credit cards, charge cards, and debit cards will be here for some considerable time. They possess good consumer and merchant acceptance now, and will continue to be used (in conjunction with physical presentation of the card as a means of payment) for in-person purchases. With PINs and smart cards, these forms can be used for on-line purchases of services as well. The current generation of Minitel, the French national information services system, accepts Carte Bleue for payment. The greatest threat to the continued success of these methods is perhaps their current success. If current success leads to complacency, and a feeling that credit cards will always possess dominant market share in $500-$1,000 transactions, card issuers may find out about a competitor only when it’s too late to take reasonable defensive action.11

First Virtual will grow into and remain a successful bit player (pun intended) in a relatively small niche, piggybacking on the payment-acceptance infrastructure provided by MasterCard and Visa and the widespread consumer recognition of these two credit-card providers as reputable intermediaries who can solve the problems of security and real-time authentication. Merchants too small to afford a full-scale Visa/MC merchant account will benefit, but these small players taken in aggregate will not comprise a major market segment. Ultimately, if their security system offers

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10 In this context, a positive verification checks to see whether enough purchasing power remains on the card to complete the requested transaction. A negative verification checks to make sure that the card has not been canceled or reported stolen. Most current credit and debit card systems build both positive and negative verifications into routine transactions, at the cost of processing time.

fundamental advantages over other forms of transactions, First Virtual will be bought by America Online, Prodigy, the Microsoft Network, or some alliance of the above. If such fundamental advantage is not forthcoming, First Virtual's admittedly useful function will be quietly duplicated by dozens of competitors, eliminating its profitability.

DigiCash bv's ecash product remains, perhaps appropriately, an enigma. On the one hand, on-line accounting, even of very small transactions, is a technology developed in the 1970s for timesharing on mainframe systems. Just as users were billed per CPU cycle, pages of printer output, or minutes of connect time, users can be billed for newspaper articles à la carte [or compensated for viewing commercial advertisements] by the on-line service, with either a detailed monthly statement or direct debit of a preauthorized bank account or credit card. A vendor whose monthly volumes are too small for Prodigy to serve will likely also be too small for DigiCash. The carefully crafted anonymity of ecash is vulnerable to regulation; tax authorities will not let large amounts of cash flow about undetected without some party being accountable for its tracking. New theft possibilities are created by leaving money on a hard disk that's left in the office overnight, rather than in a wallet that's carried on one's person at most times. On the other hand, ecash may yet prove to be the ideal tool for paying for services not yet envisioned—but there's simply no market for it in the immediate future if alternative electronic cash systems such as Mondex can achieve critical mass.

4. Conclusions

In the presence of broad-based change in payment worldwide, it would be naïve to assume that cash will continue to be the dominant means of making small, in-person payments. Rapid changes in the UK system for periodic, predictable payment have led to the typical UK bank customer writing only 4-5 checks per month (as opposed to 25-30 for U.S. households), with the remainder of normal transactions handled by direct debit. Similarly, transactions that in the U.S. would be handled with cash or credit card are handled in France by check (even for very small transactions) or Carte Bancaire (even for very small and large ones).

There will be a continuing need for small, off-line transactions and a role for stored value cards. There will also be a rapidly increasing need for a payment system to handle Internet transactions: at present it is difficult to predict who will control this market. Whether this market will be eventually claimed by one or more of the traditional competitors such as MasterCard/Visa or major banks or by new competitors such as Mondex or ecash remains to be seen.

Figure 1. Flows of Physical and Electronic Currency in Mondex System

![Mondex System Diagram](image-url)