RE-ENGINEERING TRADING AND TREASURY OPERATIONS IN INTERNATIONAL FINANCIAL SERVICES

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ABSTRACT

Maximizing business value of investments in hardware, software and telecommunications technologies that occur in the trading and treasury operations of an international bank requires senior management to evaluate the extent to which the technology infrastructure enables the bank to perform a number of key functions. These include: formulating effective trading strategies, pricing financial instruments accurately and rapidly, being able to respond to changing market conditions, processing transactions cost-effectively, resolving inquiries quickly, and moving to support emerging corporate treasury products. After a decade of rapid growth in investment levels, senior managers now emphasize refining, rationalizing and integrating trading and treasury technology architectures to support improved global financial risk management, better capital utilization, and higher transaction volumes. This chapter examines how senior managers can accomplish these goals by *re-engineering* pre-trade, trade execution and post-trade business processes. It presents a framework that utilizes basic concepts from management science and microeconomics to illustrate the variety of impacts that re-engineering can have on improving firm revenues and controlling or reducing costs. It also presents a series of managerial recommendations based on the framework.

INTRODUCTION

Background

During the late 1970s, Walter Wriston, then chairman of Citicorp, characterized commercial banking as a fast-paced "information business". Nowhere is this observation more true than in the arena of international financial services. Every day, billions of dollars exchange hands, reflecting the many transactions that must be processed to support international lending, trade finance, and money market trading and corporate treasury operations. Although each of these areas has grown during the last decade, especially notable are the changes associated with the trading and treasury business, where the lightning pace of the business and the extent of the financial risks involved place a heavy emphasis on information. Trading income from foreign exchange operations among the large money center banks, for example, increased anywhere from 40% to 1350% between 1979 and 1988. Meanwhile, the banks invested heavily in trading and treasury information technologies (**IT**) to support this large increase in transaction volume, and to improve reaction time in rapidly changing markets. In 1988, U.S. commercial banks were estimated to have spent almost $1 billion on trading systems *alone*, with *total* systems expenditures amounting to about $5.3 billion. See Tables 1 and 2.

INSERT TABLES 1 AND 2 ABOUT HERE

Throughout this period of aggressive investment, it became increasingly evident that the application of the variety of new technologies would ultimately need to be refined, rationalized and integrated to enable the banks that invested in them to continue to reap high payoffs, as their competitors caught up by installing their own proprietary applications and value-added vendor solutions. As one industry observer commented: "In the 1980s, trading floors ... looked like 'spaghetti junctions', as banks rushed to buy the latest hot box of electronic tricks" (*The Economist*, October 3, 1992, p. 24). Relatively little thought was being given at the time to creating the basis for a common or integrated set of trading and treasury platform technologies. With the relatively high margins that were available for firms that beat their competitors to market with new financial products, everyone was too busy making money to concentrate on *maximizing the business value* of their information technology investments.

New Attitudes: Risk Management, Reaction Time and Profit-making

But since the market crash in October 1987, and with the overall slowdown in domestic and international economic growth, attitudes on Wall Street have changed considerably. New opportunities are fewer and further between, more firms are going after them, and it takes a more sophisticated, cost-effective technological approach than ever before to turn them into profit. As a result, today greater emphasis is placed on the effective management of financial risk, ensuring that capital is efficiently allocated and utilized, that client and counterparty risks are properly estimated, and that all of the elements of a trading operation -- from front office sales and analysis to back office transaction processing and settlement -- are "in synch".

Profitability and performance in trading and treasury operations, like almost all other primary commercial bank lending functions, are subject to systematic market risk (foreign exchange rate fluctuation, import-export trade volume effects, central bank monetary policy shifts, changing interest rates, etc.) and the specific risks (cash flow problems, credit and bad debts, fraud and failed deals, etc.) associated with client firms. As a result, one important use of information systems is to identify and to quantify those risks. In trading and treasury operations, however, the extent of the financial risks often only may become apparent when individual positions are aggregated. Some positions may be differentially sensitive to changing market indicators, while others may move in tandem with each other. Still others may be offsetting, acting as natural hedging instruments for each other.

Although managing and controlling the financial risk of an international commercial bank's trading and treasury portfolio is *necessary*, there is widespread recognition on the part of senior managers in international financial services firms that it may not be *sufficient*. Instead, *reaction time* is often what distinguishes the high profitability firms that lead the industry from the hard-charging also-rans. One case in point is Morgan Stanley Japan, an arm of the international investment banking firm that is headquartered in New York City. Morgan Stanley invested $35 million in developing a trading system which would be faster than any other system on the street in Tokyo. Why? So that the firm is able to react faster than its competitors, on each trade, taking advantage of arbitrage opportunities that other firms are not able to act on. As one of the firm's traders in Tokyo told an interviewer, "... two or three seconds make the difference between profiting from opportunities and just watching them whiz by" (Adrian and Kelleher, 1993, p. 1).

FROM CORE BUSINESS PROCESS AUTOMATION TO GLOBAL SYSTEMS INTEGRATION: EVOLVING ARCHITECTURES FOR INTERNATIONAL BANKING

To understand the opportunities that changes to existing trading and treasury platform architectures can create for firms that undertake re-engineering projects, it is useful to establish a basis for understanding where most firms are today, and how they fit into the context of the international financial services industry. We can do this by examining four phases of automation, the rationale behind them, and the kinds of strategies that they have enabled the firms to pursue. The four phases include:

(1) creating systems that automate core business functions;

(2) deploying customer-driven systems that leverage core automation to generate new sources of revenue;

(3) enhancing customer-driven systems so that they enable the firm to control and balance risk and reward; and,

(4) integrating core business process automation, customer-driven systems and mechanisms for controlling risk and improving profitability so that they can deliver seamless, high

quality services on a global basis.

Phase 1 -- Core Business Process Automation

The first phase of IT investment in the industry involved systems that were first constructed in the 1960s and early 1970s to support the high cost, largely manual operations in several business areas. These include: electronic funds transfer and telecommunication; deposit processing and international deposit services; international trade services, letters of credit and documentary collections; lending, credit evaluation and asset management; and trading and treasury management. Even then, the investments were made with competitive cost pressures in mind. American international banks were profitable and expanding rapidly overseas, and automation of international business operational processing paralleled other efforts that were made at the time to automate domestic corporate and retail operational processing.

Cost reduction pressure became an increasingly important concern as the international banking business became more complex in the mid-1970s. But, by then, investments in each of the areas remained uneven. Trading operations remained largely manual in global trading and treasury management services. Automation for international funds transfer, however, was progressing rapidly, preparing the way for the coalition of European and American banks that formed SWIFT, the Society for Worldwide Interbank Financial Telecommunication, as a standards organization to promote standardized, cost-effective solutions to mounting telecommunications costs. Other major efforts were devoted to setting up bank-wide transactions processing, customer information databases and account reporting information systems. Core business process automation provided a tremendous amount of operational performance information to senior management, and it streamlined the process of conducting periodic audits of bank profitability.

Phase 2 -- Customer-Driven, Value-Added Systems

These systems were later built on top of the existing core business process automation. They were meant to extend the set of capabilities that enabled better operational reporting within the bank to its customers *outside the bank*. Efforts to deploy this second generation of international banking systems began in the mid-1970s, and extended well into the mid-1980s. During this time, transaction processing information systems were enhanced to capture data on transaction processing in real-time so that they could be reported to clients, who were just beginning to practice intra-day treasury management of the international source demand balances. And, the international funds transfer business was transformed by the emergence of SWIFT, and the willingness of banks around the world to adopt its standards for financial telecommunication.

Automation in trading and treasury operations during this time increased the firms' responsiveness to changing markets, through the purchase of video market data feeds and direct telecommunications and systems links to overseas offices in important markets. But because there was relatively little pressure from senior management to control costs and focus on integrating systems, the usual practice among the large international commercial banks was to build (and only rarely buy) isolated systems to support trading on an instrument-by-instrument basis. As a result, most banks' trading platform systems remained fragmented well into the 1980s: databases were not integrated, applications could not talk to one another, and most important, key trading systems did not feed data to senior management for risk management purposes in a very usable format. Given the extent of the fragmentation, it would later become very costly for the banks to achieve further integration to improve managerial control.

Phase 3 -- Consolidated Financial Risk and Profitability Management Systems

The next round of investments was built on a solid, but fragmented foundation of existing core automation and the customer-driven, value-added systems. Investments in this area began to occur in the early 1980s. In this phase, the earlier core business process systems, along with the customer-driven systems, were linked to the banks' *internal control* systems. In trading and treasury operations, senior managers increasingly realized the need to monitor and to adjust positions in response to breaking economics news, interest rate and foreign exchange price changes, intra-bank capital allocation policy changes, and changing counterparty risks. This also led to a new emphasis on developing performance and risk management metrics that could be applied to a variety of instruments, yet deliver consistently reliable and useful information to senior management. Efforts in this area were justified in large measure by changing perceptions of what was required to achieve solid profitability: many had come to believe that high profitability could only be achieved through business tactics that emphasized avoiding lower margin lending and trading in markets and in instruments that entailed excessive risk. In instances where a firm was exposed to risk, the presence of adequate controls became even more important.

Phase 4 -- Globally-Integrated International Banking Systems

An added complexity that international financial services firms face is achieving integration on a global basis. The challenge of deploying globally-integrated systems is perhaps the greatest challenge of all. Cost-effective strategic product delivery systems for the mid to late 1990s will require integration across multiple business operating environments, across different currencies, across different technical environments, and also across different regulatory environments. They will require more vision from senior management than ever before, because the scope of the international banking business has changed dramatically in the last five years. Margins are thin everywhere, speed is of the essence, comprehensive control is mandatory, and getting the information technology infrastructure right can make or break profits in trading and treasury operations.

Current Status

The current status of many large money center banks with respect to the four phases we have described reflects some mixing of the stages. International commercial banks rarely have the time or resources to focus on "everything at once." Instead, their IT architectures have been built up piecemeal, reflecting the competitive demands of participation in specific businesses. As a result, it is not uncommon for a firm to be simultaneously implementing customer-driven applications to support business in one area, while seeking to refine risk management practices and extend them to the range of its global operations. For example, in one firm one we recently visited, efforts were underway to deploy expert systems for foreign exchange trade error evaluation and multiple instrument hedge position creation and risk management, in support of specific business objectives. Meanwhile, senior management was conducting a comprehensive and critical review of the information technology platform for the entire portfolio of customer-driven systems related to trading and treasury. The purpose of the latter effort was to determine how to re-engineer the IT architecture to enable object-oriented design concepts to be incorporated in the next generation applications.

In fact, a cottage industry of conferences and seminars has sprung up of late, indicating the extent of the interest in the industry to find workable solutions to re-engineering trading and treasury operations for the global banking environment of the 1990s. Similar pressures are felt by bankers who specialize in credit evaluation and lending, and other international banking functions. On the credit side, bad debts as a percentage of total bank assets in the U.S. increased from 2.24% in 1989 to 3.03% in 1990. In the absence of effective information systems that could have helped to control the mounting bad debts, federal regulators have called for the banks to set aside additional reserves for bad debts. David Gibb, a senior vice president for credit quality and information technology at the Canadian Imperial Bank of Commerce, comments: "[I]f the crisis has served one purpose, it has alerted the banking industry to the neglect of MIS by commercial credit operations" (Caldwell and Violino, 1991, p. 10). Managing financial risk is a major weakness in several business areas represented in international commercial banking -- and one that cannot be adequately addressed in the absence of improved integration of core automation, customer-driven systems, and risk and profitability management applications.

We now turn to a more detailed consideration of the hardware, software, and telecommunications technologies with respect to which re-engineering projects can be undertaken to improve pre-trade, trade execution and post-trade operations in the trading and treasury business process.

PRE-TRADE, TRADE EXECUTION AND POST-TRADE PROCESSES

There are several ways to understand trading and treasury business processes for the purpose of improving performance. One way is to focus on the *content* of the trade. The treasury and trading business can be studied by segmenting the business according to product lines. For example, traders can trade Treasury bills, mortgage-backed securities, or foreign exchange. The key question is: What is being traded? This focus is important when trying to determine the contribution of each product line to the bank's total profits.

Another way to understand the treasury and trading process is to analyze the *process* of performing the trade. Here, the focus shifts to the work and procedures and the flow of work that occurs when something is traded. The emphasis is on *how* the product is traded. The key questions is: How does trading work, and how are the workflows changed? A third complementary perspective is to examine the participants or *actors* that populate the trading process. The related question that this perspective suggests is: How do the actors' responsibilities change, and how are the relationships among actors changed? The last two can be combined to form a useful perspective for senior management to adopt when re-engineering of business processes is of interest. In particular, with increasing integration of intra-firm operations already underway, a careful reconsideration of the boundaries of the organization can expose new ways of creating new business opportunities and simplifying workflows at the same time. In this chapter, our focus is on the *process* of trading and how the *actors' roles* in that process are changed; *what* is being traded is of secondary importance. We will describe the overall process of trading and the key participants in each phase.

A practical breakdown has been suggested by practitioners in finance to describe the process of trading in terms of three time-dependent sets of activities (Green, 1993; Waters Information Services, 1991):

(1) *Pre-trade processes* occur before the trade is made, for example, pricing or swap analysis, price change forecasting, or position hedging evaluation.

(2) *Trade execution processes* are required in order to initiate, process and complete trades.

(3) *Post-trade processes* occur after the trade is made, but are necessary to ensure that the appropriate adjustments are made on a firm's books, that funds are transferred into or out of the appropriate accounts to effect settlement, and that any errors that result in inquiries are resolved.

Figure 1 depicts this breakdown and lists the various sub-processes that are associated with each of the major processes.

INSERT FIGURE 1 ABOUT HERE

Pre-Trade Processes

Pre-trade processes include all those activities which occur prior to the trade of a money market instrument. They include the following:

- client needs assessment, credit allocation decisions,
- identification of counterparties for trades, and
- valuation and risk analysis.

Assessment of customers' needs and credit allocation decisions are based on background research and constant contact with customers. These decisions determine what services the traders can perform for the customers. The identification of a counterparty is essential to complete a trade. The search for a counterparty could be initiated by the trader (say, in response to a request by another trader), or by a member of the "sell-side" team -- beginning with the relationship lending officer or the treasury product specialist -- who initiate contacts with customers.

Finally, *analytics* -- a term used widely in the industry to mean computer-based support for quantitative problems in trading -- provide the basis for improving trading decisions. The input to the analytical systems is a wide range of market indictor data (Waters Information Services, 1991). Analytical systems provide the trader with the ability to build models, to perform on-line position analysis with relevant customer and potential counterparty information, to implement real-time risk management of customer portfolios and trader positions, and to create graphical and numerical reports that offer insights into the sensitivity of trading or hedging strategies to changes in market indicators.

International banking introduces additional complexity into the above processes by requiring traders and management to track additional variables. First, banks must continuously value their portfolios in real-time and keep databases consistent in order to be able to "pass the book" from one office as it closes to another in a different geographic market, as the market opens up. Second, for management to keep in touch with the impact of developments in the firm's markets on specific businesses and bank customers, global, local and customer profit and loss statements need to be created. Third, because there are country-specific risks related to trading in different national markets, it is also necessary to track developments in real-time in other countries.

Trade Execution Processes

Trades are effected in two parts: an order is taken, and the trade is executed. Historically, these processes were handled by at least two different people: the trader wrote the order on a piece of paper, and another person physically took it over to be entered the order into the firm's order system. From there, the order was routed into the execution system. Today, the technology has enabled these two processes to be unified. Workstations provide the trader with the capability to enter trades, check for errors and edit. They also offer on-the-spot position measurement capabilities.

The major technological capability that is required for trade execution is a high speed on-line transaction processing system that is able to process trade entries from the workstations. Orders credited through arbitrage opportunities identified by the computer can be routed automatically. The function of the system is to create a "time-stamp" for the trade as an event in the bank's business, and to send a notice to the market that the event has occurred. In the absence of such notification, the opportunity for another competitor to make the trade still exists. In practice, on-line screen-based trading systems are very fast. Currently, designing an effective transaction processing system requires reaction time in the one to two second range.

Post-Trade Processes

Post-trade processes include the following:

- updating positions and risk exposure,
- transferring funds,
- handling inquiries and one-of-a-kind requests.

Position update occurs after an order has been effected, and the trade has been time-stamped and sent to the market. A number of calculations are performed to update customer and counterparty positions, the trader's position, and apply them to the bank's aggregate position. As a result of these calculations, post-trade processing also enables the computation of useful quantitative information for risk management purposes, including instrument, customer and market exposures. Most banks calculate these at the end of the day. However, some banks are moving towards operating on a real-time basis.

The *flow* of *funds* and settlement procedures are based on the trade. In some cases, the trades only require book entries: banks often promote trades between customers, and they often act as the counterparty to the customer's trade. In cases where the counterparty is the client of another bank, money market trades are completed by the movement of funds through domestic money market bank funds transfer networks such as CHIPS (the Clearing House Interbank Payment System) in New York or CHAPS (Clearing House Automated Payment System) in London, or through notification via SWIFT for later settlement. This part of the process is usually called "clearing".

The final major component of post-trade processing is *handling customer inquiries*. It is important for an international commercial bank to operate a high quality, low error trade transaction processing system. Of course, some errors will inevitably occur. However, when they do, computerization can support inquiry handling by enabling a customer service representative to do an on-line trace through a trade transaction's audit trail, correct the part that is in error, and enable the relevant updating information to be passed to the bank's other customer account and intra-day position information systems. It is imperative for the bank to be able to resolve problems quickly; when they aren't resolved, the bank will occur two costs. First, when the trade finally is corrected, the bank must "back value" funds that were incorrectly applied or that were not received by the customer. This represents a real expense to the bank, and is a function of the dollar value of the underlying transaction, the current funds rate, and the number of days the position is in error. Second, trades processing operations that are prone to making errors attract fewer customers in the long run, which reduces operating scale. This can force pricing changes, which may also cause the bank to lose customers.

Actors in the Trading Process

Table 3 presents an overview of the participants in each of the stages of trading.

INSERT TABLE 3 ABOUT HERE

The major participants in the pre-trade phase are the lending or marketing officer, the senior credit officer, the treasury product specialist, the customer, and the trader. The first two are responsible for bringing to the bank customers who require trading and treasury services. The lending officer makes proposals for the allocation of credit (actually scarce capital resources) so that the bank can trade on behalf of the customer. The credit officer has the authority to decide how to allocate capital. The treasury product specialist acts in an advisory role, in conjunction with the lending officer and the trader, to create value maximizing short-term and long-term treasury strategies. The treasury product specialist is often responsible for suggesting what kinds of trading activities the customer should engage in, performing quantitative analysis and research to determine how customer positions should be hedged, and so on. The trader and the customer are also direct participants in this process; the former can offer insights on the feasibility of a treasury management and trading strategy, based on deep knowledge of how markets operate, while the customer must inform the trader about important events in its business operations that require changes to the firm's position.

The major participants in the trade execution are the customer, the trader, and the counterparty (which is often the bank itself). In executing the trade, the trader may directly enter the trade into the computer system, which is known as screen-based trading, or the trader may pass the trade on to an order taker, who enters the trade and routes it to the next point in the process.

Finally, in the post-trade phase, the key actors are those responsible for analyzing the effects of the trade, and facilitating the full execution and follow through. In this phase, the risk manager evaluates the risk associated with the new positions. Funds transfer managers play a role in the post-trade process in that they are responsible for any movement of funds that the trade execution requires in order to settle. Customer service representatives provide information to customers and auditors, and collect information from customers, often to resolve errors.

Identifying actors' roles is useful in understanding the workflows involved in trading operations. For example, instead of just generally knowing what pre-trade processes are, one can identify the tasks and the actors which comprise this process, and thus understand the workflow at a more detailed level. After understanding the workflow, role identification and analysis can then help to determine re-engineering opportunities by raising the following issues: Is the role necessary? Can it be combined with another role? Can it be "exported" to the customer or supplier? Can the role be eliminated altogether? We return to this point in the re-engineering section of this paper. First, however, we discuss the hardware, software, and telecommunications and data feeds that are common to modern trading and treasury operations.

RE-ENGINEERING OPPORTUNITIES FROM HARDWARE, SOFTWARE AND TELECOMMUNICATIONS TECHNOLOGIES

The information technologies that global trading and treasury operations in international banking use can be grouped into three broad categories: hardware, software, and telecommunications and data feeds. Some of the capabilities that the different technologies offer may appear to be obvious and trivial to implement, but very often implementation is problematic because of the constraints imposed by existing systems. For example, traders would often like to pull data off a screen display of market indicators, and use it in the context of a workstation-based spreadsheet money market instrument pricing model. But this is only possible if the data source is digital, and if the bank has a data stream capture device that can move data from the screen and into a spreadsheet. Let's examine what opportunities there may be for firms to re-engineer their existing trading and treasury operations in terms of these three categories of technologies.

Hardware

International trading and treasury operations use a wide range of information technology hardware. In the 1960s and 1970s, *mainframes* were the primary focus for transaction processing and customer account reporting. This continues to be the case, but usually mainframe processing capabilities are supplemented by fault-tolerant minicomputers that maintain a steady stream of processing that enables trade-related data to reach the market. Mainframes have been the traditional number-crunchers that banks use to post and clear the high volumes of trades that are executed daily. As we noted earlier, high-speed on-line transaction processing is a basic requirement for trading and treasury support. But mainframes are also used for handling databases of financial data that are typically stored on direct access storage devices (**DASD**) so that they can be called for use in analytical models and for other forecasting purposes.

Although mainframes are fast and powerful, they are not nearly fast or powerful enough to solve highly complex analytical models in real-time. Merrill Lynch, for example, bought a *massively parallel supercomputer* to do pre-trade analysis related to the pricing of mortgage-backed securities (**MBS**), a money market instrument that became increasingly interesting to bank portfolio managers and traders in the mid-1980s (Michaels and Jenna, 1992). The challenge in MBS pricing involves estimating prepayment cash flows that occur over time as an interest rate moves stochastically through a "binomial lattice" of potential interest rate paths. When interest rates fall, borrowers refinance mortgages to obtain the lower rates, reducing the payback for a money center bank that holds the mortgage debt in its *securitized* or MBS form. Assuming that the life of a typical mortgage is about 30 years, and interest rates and prepayments are tracked on a month to month basis, the number of potential scenarios that might obtain is 2^{360} (Zenios, 1991). In practice, a mainframe would take days to solve this kind of problem, effectively eliminating the opportunity for Merrill Lynch to participate in this business. By bringing in a massively parallel system (where several thousand scenarios can be explored simultaneously), the firm has increased the functionality of its system. Merrill Lynch also believes that it can take advantage of more trading opportunities from the increase in speed (Michaels, 1992). Other firms in the securities industry are reported to have applied supercomputing solutions, including Prudential Securities, which has been using them since 1988 (Michaels, 1992), and the Union Bank of Switzerland (Kang and Zenios, 1992).

International financial services firms are also able to increase their cost effectiveness by moving some of their analytics, including statistics, graphics, modeling, and hedging, off mainframes to *workstations* and to *personal computers*. Senior managers note that workstations offer more "economic MIPS". Cost is not the only concern though. Developing mainframe processing schedules in a large international bank involves sorting through the priorities of the many competing business units, all of which are in search of cheap and reliable processing. Ivy Schmerken, a senior editor with an influential industry periodical called *Wall Street & Technology* (previously known as the *Wall Street Computer Review*), comments on the move to distributed processing:

Wall Street's vintage back-office systems are a messy patchwork quilt of incompatible minis and mainframes that make it difficult to consolidate a firm's positions, credit exposure and capital allocations across global markets. By distributing the processing on workstations, positions can be updated in real-time right at the trader's desk, so that risk managers don't have to wait for several hours for mainframe reports. (Schmerken, 1992b, p. 84)

Traders prefer workstations over personal computers, because workstations operate about two to five times faster than the fastest personal computers. As a result, trading platform technology designers increasingly moved the analytics to workstations towards the end of the 1980s and the early 1990s. Workstations predominantly use reduced instruction set computing (**RISC**) chips, which are faster and more economical than the microprocessors used in personal computers, especially for data-intensive numerical computations. Merrill Lynch, for example, has deployed about 1500 Sun Microsystems workstations (Schmerken, 1992a, p. 61).

An important hardware infrastructure design decision is the choice between *proprietary solutions* and *open systems*. The trend today is against proprietary hardware and operating systems. Companies such as Rich Inc. (owned by Reuters Holdings PLC) and Micrognosis (a subsidiary of Control Data Corp.), which previously enjoyed the profitability benefits of dominating the markets for proprietary trading floor hardware and software solutions, are now challenged by the growing industry-wide call for open systems, exemplified by *open* hardware like Unix workstations and microcomputers.

As banks continue to modernize their trading systems, the move to consolidated digital feeds and workstation analytics is evident. This also requires computational power on the trader's desk, a large windowed display format, and a mouse-driven or push button data entry interface to supplement the keyboard. With multiple windows -- each displaying their own data feed -- and consolidated analytics, a trader workstation's windows become "windows on the world markets". Such consolidation will also offer cost savings: every time a market data vendor develops something new, the bank no longer will need to bring in new hardware to support it. No bank wants to be locked into and limited to one firm's products: the trading and treasury business, and the set of hardware technologies that can be used most effectively to support it, are changing too rapidly.

Software

Although the hardware platform is an important investment for an international commercial bank, what really makes it pay off for the bank is the software that it can run, providing decision support, trade execution and inquiry support services, and retrieval of relevant information about the world from market data. The trading and treasury services that a bank can offer are dependent upon the capabilities of the software and hardware mix; more complex pricing algorithms and financial instrument analytics can be designed precisely because the capabilities of the hardware are growing. The major firms have invested a substantial amount of time and money in software to support trading, in part because such investments are viewed by senior management as giving the firm leverage to increase non-interest revenues. In some banks, the rapid deployment of new software to support trading in new instruments and the offering of new financial products has created businesses where there were none before.

Just as there is a trend towards open systems in computer hardware, there is also a trend towards open systems in software to support international trading and treasury functions. Software applications can be classified in one of two ways:

- *Proprietary applications software* is usually developed in-house or on a customized, outsourced basis, where the explicit intent is that the software will produce competitive advantage for the firm.

- *Open applications* result from joint development undertaken by a group of firms who form an alliance, or by an industry outsourcing firm that works with an industry firm to create a non-proprietary solution, that can later be resold to other firms, so that the price to early purchasers will reflect development costs that can be spread over multiple firms.

Proprietary software includes *programmed trading* applications, which are essentially financial strategies of a firm which have been programmed into a computer. In programmed trading, several transactions are executed at the *same* time; for example, several currencies, or their futures or options, can be bought or sold, in varying quantities. The New York Stock Exchange defines programmed trading as "the simultaneous purchase or sale of at least 15 different stocks with a total value of $1 million or more" (Wall Street Journal, March 17, 1993, p. C15). An important application of programmed trading concepts is to implement arbitrage strategies. Arbitrage strategies take advantage of mispricing which may occur between a currency on one exchange, and futures or options of that currency on another exchange. The trader has the computer programmed to do two things:

(1) to recognize an arbitrage opportunity, and,

(2) to execute certain trades based on that opportunity.

The program monitors market data and initiates the trades.

Due to the magnitude of the investment required to develop trading and treasury infrastructure software and programmed trading applications, the adoption of industry standards for software development and software alliances has become increasingly attractive. Some firms have actually sold or licensed their own in-house systems to defray the costs. For example, The First Boston Corporation, a New York City-based investment bank, licensed a computer aided software engineering (**CASE**) tool called High Productivity Systems (**HPS**) to Kidder Peabody, an industry competitor with a greater focus on retail securities trading, to defray the $120 million cost of developing the CASE tools and an entirely new set of trades processing architecture software (Banker and Kauffman, 1992).

In addition to being cost-effective, another potential benefit of open systems is that they allow for a modular and flexible software architecture, which accommodates new approaches to software engineering that emphasize software object reuse and object-oriented design (Karimi, 1990; Apte, Sankar , Thakur and Turner, 1990). Software design and object reuse opens up the possibility of "win-win" cross-industry alliances. One such example is the alliance involving six firms, including Financial Technologies International (**FTI**), a New York City-based software design consultancy, IBM, and four financial services firms (Pierson, Heldring & Pierson; U.S. Trust; Wilmington Trust; and Wachovia Bank). These firms have jointly developed several common, *software alliance applications* (including portfolio accounting, customer information, access security, corporate actions and income collection, transaction entry and maintenance, organization information, financial instrument and price information, and payment processing) and several proprietary applications (including performance measurement, analytics, customer workstations, customer reporting, and tax services) (Rolandi, 1993). The financial services industry participants in the software alliance benefit from not having to invent the same wheel four times; and, they can also benefit from their proprietary applications developed jointly with IBM and FTI.

Telecommunications and Data Feeds

Walter Wriston, in his recent book entitled *The Twilight of Sovereignty: How the Information Revolution is Transforming our World,* comments:

> *The new world financial market is not a geographic location to be found on a map but, rather, more than two hundred thousand electronic monitors in trading rooms all over the world that are linked together. (Wriston, 1992, p. 62)*

More than any other single transformational force, the advent of modern, real-time and low cost telecommunications has become the glue that holds the world markets together.

There are two aspects of telecommunications which are critical to trading and treasury operations: the "data highways", that is, the cables that connect the vendor data feeds to the traders' screens, and the "voice highways", that is, the cables that connect the traders' clients and other traders to the trader's phone system. Waters Information Services (1991) points to *high-density key telephone systems* as the primary technology enabling voice communications, and they should be considered as a basic trading room technology. Trading platform phone systems handle anywhere from 40 to 120 lines, enable programmable and automated dialing to one of many potential locations (most often traders at other banks) and provide instantaneous identification of the firm from which an incoming call originates. Traders often hold multiple conversations at once -- spanning the full range of the international markets to obtain relevant information -- with the outcome of transactions involving millions of dollars depending on what transpires in the conversations. A trader's work is mentally and emotionally demanding, and the work environment is often hectic, literally bubbling with information obtained in phone conversations or via screen-based information sources.

The largest firms track the market by acquiring real-time data on specific market indicators, including Treasury bill and bond rates, foreign exchange spot and forward prices, and prices on options and futures. They also track real-time news from other markets, where new developments can influence money market prices. Data feeds are usually of two types: video and digital. *Video data feeds* are video images (based on analog signals) of pages that contain data about the market or a group of financial instruments in a fixed format. Video pages cannot be decomposed into individual elements, in the same way that a television viewer would be unable to pull product prices off of a televised advertisement and insert them into a spreadsheet program. *Digital data feeds*, on the other hand, can be manipulated to support computations for real-time financial decision modeling and early warning alarms of key changed in the market.

Examples of digital data sources relevant to a money market bank's trading and treasury functions include the Chicago Board Options Exchange, and the New York Stock Exchange, as well as market-specific services from firms such as Reuters, Telerate, ILX, Nikkei and Dow Jones. These "quote vendors" (as they are often called by industry practitioners) consolidate data from the exchanges, from central banks worldwide, and from governmental or private sector sources, and repackage it for digital transmission.

An example of a Telerate screen, which displays foreign exchange quotes, is shown in Figure 2. As well as numeric data, there is also textual news data at the bottom of the screen. The largest international commercial banks also purchase specialized data sets for infrequent or customized analyses.

INSERT FIGURE 2 ABOUT HERE

David Leinweber, chief scientist at Integrated Analytics, a firm specializing in the development of pre-trade applications that are embedded in financial market trader workstation software, comments about the importance of high quality data in the context of "intelligent" securities trading systems:

> *All data feeds are subject to errors and delays. When these arise at the primary feed provided by exchanges or NASD (the National Association of Securities Dealers), they will generally be passed on without correction by the providers of the feeds. Other errors and delays can arise from causes internal to the secondary feed distributor, such as line problems, radio interference, and queuing delays in processing. Published reports cite instances of one feed lagging another by up to one minute. In the absence of accurate time stamping at the point of origin, the feed integration system must take the responsibility for selecting the most timely data. Obvious transmission errors need to be detected and corrected. Human users will spot these errors, but it is inefficient to require each and every analytic tool in the trader's arsenal to verify the same data repeatedly. (Leinweber, 1989, p. 313)*

In summary, there is already an extensive installed base of technologies that make up the infrastructure of trading and treasury operations. We now present a new conceptual framework to characterize re-engineering opportunities, with the ultimate goal of identifying ways that international financial services firms can better leverage information technology to improve their business performance.

RE-ENGINEERING TRADING AND TREASURY: AN EVALUATIVE FRAMEWORK FOR SENIOR MANAGEMENT ACTION

Senior executives in international commercial banking talk about re-engineering in the same terms as the most well-known industry consultants. Re-engineering primarily means obliterating, to the furthest extent possible, all "non-value-added" activities that occur in the business. In practice, this means eliminating a task, job, role or operational process if it does not add to the revenue stream of the bank in a direct or indirect manner, or if it adds costs that are not deemed essential to support the operation. Based on the case studies that are cited in the industry press, operational cost cutting, for example, in international funds transfer, loan review, check processing and letter of credit operations is the most often pursued goal. This normally results in improved operational performance and productivity measures, such as funds transfer inquiries resolved per inquiry staff member, operational errors as a percentage of total transaction throughput, or the number of letters of credit or documentary collection transactions processed per clerk.

The emphasis placed on the role of technology is one of *substitution*: rising variable costs can be replaced with a fixed cost technological component that gets the job done as well (or perhaps even better) at a lower (or nearly equal) cost. In this section, we will consider the following question: Given that re-engineering efforts can be aimed at either cutting costs and increasing efficiency, or achieving product and service differentiation to leverage revenues, which of these offers the greater opportunity in the trading and treasury arena?

We can answer this question by employing perspectives derived from a framework for understanding re-engineering in terms of two elements:

(1) the *re-engineering objective function*, and the constraints within which senior management can attempt to optimize it; and,

(2) the *business value levers* that senior managers have at hand to affect the business outcome measured by the objective function.

We will now examine each of these in greater detail.

Primal and Dual: Formalizing Revenue and Cost-Driven Re-engineering Alternatives

Management science, operations research and managerial economics suggest avenues along which it might be possible to construct a formal evaluative framework in which to analyze the re-engineering opportunities in trading and treasury operations. An analyst should begin by asking the basic question: What is the objective function that re-engineering efforts seek to optimize? In our view, there are two general approaches that parallel the ideas we have already expressed above, and which we will call *primal side re-engineering* and *dual side re-engineering*. The terms come from the primal and dual problems that are often the subject of basic analysis in introductory texts in these areas (See, for example, Varian, 1985). They are based on the idea that a rational managerial decisionmaker will undertake actions that seek to maximize the expected value of the firm, subject to the contents of a set of constraints that match the business, operational and managerial environments in which decisionmaking occurs.

Primal side re-engineering seeks to solve the *primal problem*, which broadly focuses on revenues as a means to deliver profits:

$$\underset{\text{Units Sold, Unit Price}}{\text{Maximize}} \quad \textit{Profit} = (\textit{Unit Price} - \textit{Unit Cost}) * \textit{Units Sold}$$

$$\textit{Subject to:} \quad \textit{Total Costs} \leq \textit{Corporate Operating Budget}$$

The operating budget acts as a constraint within which senior management can adjust two key variables that deliver revenue: units sold and unit price. Applying this idea to trading and treasury operations, primal side re-engineering efforts basically are meant to create leverage on these two variables. They are meant to assist traders and sales professionals to effectively price the money market instruments in which they deal, and to provide the right services and products so as to generate transaction volumes that match the firm's operational scale. Primal side re-engineering, then, is re-engineering undertaken to support the trader as a seller. Done well, for example, the pricing can be adjusted to create aggressive, business-attracting margins, or to meet the demand for high margin trades that other competitors are not able to do competitively. We will shortly investigate the content of the leverage that can be created via *business value levers*, and how the objective function results can be improved.

Dual side re-engineering treats the cost-related variables by providing a solution to the *dual problem*, which can be stated as follows:

$$\underset{\text{Unit Cost}}{\text{Minimize}} \quad \textit{Total Costs} = \textit{Unit Costs} * \textit{Units Sold}$$

$$\textit{Subject to:} \quad \textit{Profit} \geq \textit{Targeted Managerial Profit}$$

Here, targeted profitability (perhaps set by the senior management committee outside of trading and treasury operations) is identified in terms of the firm's business plan, and represents a real goal to which management's actions and results can be compared. Cost minimization in this context is only rational to the extent that the business activities that are supported continue to generate sufficient revenues to enable the business to meet its stated goals.

Thinking about what re-engineering efforts can do for the firm -- in terms of the primal and the dual problems -- provides a natural analogy to the real simultaneity in which trading and treasury business decisionmaking occurs. It is not possible, for example, to offer trading and treasury services that are highly innovative and very attractive to potential clients, and thus are likely to generate new revenues for the bank, if there is no assurance that marginal revenues (inconclusive of the various risks to which trading activities are subject that will increase expected costs) will be positive. Similarly, an obvious candidate for cost cutting in trading and treasury is the elimination of the order taker. But substituting technology that enables the trader to make a trade by entering it directly into a system via keystrokes, manipulating a mouse or using voice recognition, must be shown to deliver real cost advantages over the human intermediary and not adversely affect other aspects of the business process that ensure quality and provide second checks for errors.

Let us formalize our discussion of the leverage points that are available to senior managers to achieve improved results on the primal and the dual sides in trading and treasury operations.

A Re-engineering Action Leverage Matrix

Using the primal and dual problem analogies opens up a range of useful perspectives that have been employed for analyzing profitability and cost engineering problems elsewhere. One that is especially interesting is a framework that was originally proposed by the American Productivity Center to explain profit variance in terms that reflect the change in productivity (the dual side) times the change in price recovery (the primal side) (American Productivity Center, 1981; von Loggerenberg and Cucchiano, 1981-82). Here we will employ a similar framework to define and analyze the effects that re-engineering can have on trading and treasury profitability variances, as shown in the *re-engineering action leverage matrix* of Figure 3 below.

INSERT FIGURE 3 ABOUT HERE

Decomposition Analysis Approach

Figure 3 depicts traditional accounting analysis in its most aggregated form in the center row, in which changes in profits are evaluated as changes in revenues (the output side) and changes in production costs (the input side). Re-engineering efforts, however, produce more subtle, less readily aggregated effects on the trading and treasury process. To understand the levers that are offered to change profitability, we need to further decompose the changes in revenues and production costs into changes in prices (of the inputs and outputs) and quantities (also of the inputs and outputs).

For example, by focusing on the bottom row, the analyst is able to discern the separable impacts of changing the technical efficiency of production. Re-engineering can increase output quantity while holding the operational inputs fixed, or it can decrease the input quantity while holding output fixed. Similarly, the top row focuses the analyst's attention on the elements of primal side price recovery. Re-engineering efforts that affect price recovery are perhaps of greatest interest to management: a bank that operates as a market leader in the trading of a specific financial instrument possesses special power to turn the market in its favor through the force of its own moves. As a buyer in the market, the firm is likely to be able to change the input prices that it observes, while as a seller it may also have the power to influence the prices at which it can turn trades around on behalf of its clients. (We are not arguing against the efficient markets hypothesis here; our contention is that firms that are able to discover different information earlier, and then act on it, can generate input and output price leverage and market power that will improve their price recovery.)

Column-wise analysis offers additional insights. In contrast to traditional managerial accounting analysis, one can think of changes in profits as being driven (still in aggregate, but now somewhat more descriptively) by changes in productivity and changes in price recovery. The leftmost column focuses on how re-engineering efforts can influence the revenue output side, through changes in the output quantity and changes in the output price. The rightmost column relates changes in input quantity and changes in input cost to arrive at total costs.

Thus, the right quadrants (B) and (D) focus on reducing production costs of trading and treasury products through decreasing the price (such as the cost of funds) or quantity of the inputs. The left quadrants (A) and (C) focus on adding value through an increase in output or through value-added differentiation that results in a higher prices or new products.

Quadrant Opportunity Analysis

We think that significant opportunities for re-engineering trading and treasury operations exist in quadrants (A) and (C) on the left hand side. This is especially interesting because this view contrasts with the usual goal of cutting production costs. This is often mentioned in press reports of mergers and acquisitions involving large banks. For example, NationsBank intends to save $400 million, from reducing its annual operating costs, through merging with C&S/Sovran (Crockett, 1992). Chemical had saved $50 million by the end of April, 1992 (Lipin, 1992), and intends to save another $525 million by the end of 1993 (Gullo, 1993), from consolidating its operations with Manufacturers Hanover Corp. Our view also contrasts with the moves towards big dollar outsourcing contracts, such as Continental Bank. "[T]o cut costs and remain competitive, the big Chicago bank [Continental] has been quietly automating certain trust functions through outsourcing (Fraser, 1993, p. 12A)."

Re-engineering activities that affect output price (quadrant A) and output quantity (quadrant C) emphasize different aspects of the IT platform. The lower left quadrant (C) captures speed, reaction time, capacity and other important elements that enable transaction volume to be brought to the bank. Decreasing reaction time allows a bank to increase its trading volume by seizing more opportunities -- recall that Morgan Stanley Japan executed more trades because it was faster than its competitors. Re-engineering efforts here can buy lead time and short-term revenue gains, but long-term, the technologies that must be invested in here tend to become commodities. They are adoptable by all competitors, in time as the technologies become cheaper and more readily implemented. So senior managers should recognize that the barriers to re-engineering imitation are probably quite low -- low enough so that the business value benefits are temporary gains only, and not the building blocks of sustainable competitive advantage. However, even though the benefit may only be temporary, this does not mean that the bank should not invest in these technologies -- it may be necessary to invest simply to keep up with the competition.

Re-engineering efforts that occur in the upper left quadrant (A) affect output prices. A change in output price can only be obtained when the technological enhancements to a bank's trading and treasury operating capabilities lever market power, market coverage, and new product delivery. Changes in this quadrant deal with the trading and treasury infrastructure, not as commodity technologies that are easily imitated, but as an integrated "value platform" that exploits the unique blend of expertise, capabilities and other resources available within the firm (Kauffman and Lally, 1993). *Even though the information technology may be considered to be a commodity, the value platform is not: it is unique to every firm.*

Re-engineering the activities in quadrants (A) and (C) invariably requires changing the roles of the actors involved in the process; the roles are usually either eliminated, enhanced, or offloaded to the customer or supplier. In order to increase market coverage and new product delivery, quadrant (A) activities, roles must be enhanced. For example, to increase market coverage, the role of the sell-side lending officer or treasury management product specialist, will broaden to incorporate the change in coverage. In addition, these agents' roles will also increase in depth; as new treasury and trading products are introduced, the sell-side will need to be able represent the bank's new product capabilities. In the pre-trade phase, the sell-side actor will need increased access to information and analytics in order to proactively assess client's needs and to identify how they may be met through the increased diversity of products. In quadrant (C), the role of the risk manager is enhanced. Because processing capacity increases and reaction time decreases, the risk manager will be able to perform more sophisticated analytics in the same amount of time.

The potential results of re-engineering efforts undertaken in quadrants (B) and (D) are also worthwhile to point out. The usual interpretation of what impacts re-engineering can deliver is found in quadrant (D). Gains are made by eliminating redundant and non-value-added tasks; however, we again must emphasize that such gains may not deliver sustainable competitive advantage. They must be coupled with simultaneous actions on the primal side to ensure that business volume will materialize.

Re-engineering workflows, quadrant (D), also alters the roles of the actors in the treasury and trading process. For example, unnecessary checkpoints, and the roles associated with them, can be eliminated. Data entry and validation become part of the role of the trader. For instance, voice recognition technology is being tested to help the trader enter and verify trades. In fact, the data entry role of the trader can also be taken up by the client (the client becomes the trader) if access to the bank's trading system is provided to the customer. Re-engineered post-trade processes yields simplified processes and fewer errors, resulting in fewer customer. In addition, if customers are provided access to the trading system, they can then perform their own inquires. In effect, part of the service role, typically performed by customer service representatives, is off-loaded to the customer. Fundamentally, as with quadrants A and C, this functionality requires an integrated IT platform that is easily linked to the customer.

The benefits of re-engineering activities undertaken in quadrant (B), where changes are made to affect input prices, are somewhat harder to predict. Examples of changes in this quadrant include intra-firm high-speed voice and data communications linking the firm's traders in different markets. A second aspect is efforts that enable interorganizational information systems to be put into place. A recent example is the Chicago Board of Trade's (CBOT) GLOBEX electronic trading system. GLOBEX enables foreign exchange trading to continue outside the normal hours that the primary markets are in operation in the United States. The reason that we believe that the benefits of re-engineering may be harder to predict in this quadrant is that the impacts of a single firm's re-engineering actions may be constrained by the extent to which other firms are re-engineering. For example, Chase Manhattan Corp. is trying to re-engineer its swaps trading process. It is trying to convince other banks to join together to establish a clearinghouse to trade currency and interest-rate derivatives (Layne, 1992). The success of this re-engineering effort depends on the willingness of the other banks to join the clearinghouse. When firms do join together, industry standards normally emerge, creating beneficial externalities that can drive input costs down for all market participants in the same way and formalize the manner in which everyone conducts business.

Although such externality or standards-based re-engineering may not yield competitive advantage for any single firm, the industry as a whole will produce more valuable services to its consumers. In this regard, Breshnahan's (1986) characterization of IT investments in the financial services industry as yielding "spillover" benefits is especially fitting: re-engineering efforts, when aggregated across firms which are responding to similar developments in hardware, software and telecommunications technologies, can lead to the restructuring of the industry as a whole. The move to truly global trading and treasury management on behalf of multinational corporations and banks, and the changing technological landscape that has made it possible, are bellwether developments that indicate the real power and long-term potential of re-engineering in the industry.

TIMING, RISK AND RE-ENGINEERING PLANNING CHOICES: SOME MANAGERIAL RECOMMENDATIONS

The re-engineering action leverage matrix that we discussed above is intended to assist senior managers to conceptualize where the paybacks from re-engineering are most likely to arise in trading and treasury operations. It suggests a number of guidelines and ideas for senior managers that they may find useful. Our first two guidelines are the most obvious:

Guideline #1: Take into account that re-engineering efforts in trading and treasury operations can yield both primal and dual side impacts, and that the gains can vary in their magnitude and their expected duration.

Guideline #2: Don't justify or gauge the benefits of re-engineering solely on the basis of accounting profits: revenues less costs; employ the price recovery margin and productivity metrics to decompose the impacts and evaluate the key business value levers that enable the firm to optimize its re-engineering objective function.

Salomon Brothers, for example, re-engineered its front and back office operations to save $30 million to $60 million a year. The firm migrated its trading systems from costly mainframes to cheaper workstations (Schmerken, 1991).

In addition to looking at the levers emphasized in the action matrix, senior managers should concerned about how to manage the re-engineering process to minimize the risks associated with bringing in the new hardware, software and telecommunications technologies. Our remaining guidelines point out the importance of timing and risk, and how they should be treated in managerial planning choices related to re-engineering of trading and treasury operations.

Guideline #3: Recognize the multiple sources of risk associated with implementing new technologies called for in re-engineering programs, especially in terms of the adequacy of the technical skill base and managerial know how within the organization.

Some re-engineering efforts in the trading and treasury arena stretch the available technical and human resources in ways that are wholly unexpected. One example from our own work is The First Boston Corporation's investment in a $120 million "New Trades Processing Architecture". It required the firm to construct its own computer aided software engineering (**CASE**) tool, when a study commissioned by the firm's chief information officer found that there were no available tools to cost-effectively accomplish software development to support global trading (Banker and Kauffman, 1991).

Other concerns include market and technical risks. During the late 1980s, there were a number of firms that placed bets that IBM's advanced PC-based operating system, OS/2, was going to be the dominant operating system in a few years time. Early trading and treasury platform investments were subject to the market risk that OS/2-compatible software would not emerge rapidly enough to bring the firms adequate payback for their early OS/2 investments. And, there was also the technical risk that the operating system would not develop along the trajectory that IBM projected, causing whatever investments were made to be rapidly obsolete. The record shows, of course, that Microsoft's WINDOWS has largely prevailed, even though there is enough of an installed base to have made OS/2 viable for additional development.

Guideline #4: Keep in mind that investments in IT that re-engineer the trading and treasury operating infrastructure are really capital expenditures whose greatest potential payoffs can arise in ways that are planned and managed, and also in ways that are altogether unforeseen.

Investments in infrastructure often yield benefits that cannot be predicted with any degree of precision (Weill, 1993). The development of a flexible IT-based trading and treasury infrastructure creates an "information technology option" for the firm which invests in it (Benaroch and Kauffman, 1993; Dos Santos, 1991; Kambil, Henderson and Mohsenzadeh, 1993; Kauffman, 1993). An information technology option can be exercised by the firm that invests in infrastructure or a new technology, and then later learns how to re-invest, building on top of the infrastructure to create a new capability that would not be possible in the absence of the infrastructure or the learning that occurred. As we pointed out earlier, senior managers in the industry can be reasonably sure that some of these unforeseen applications will come from further reducing "information float" in trading and treasury operations. Thus, a platform that enables "just-in-time everything" is important as the ultimate objective; not having this capability can lead to serious competitive disadvantage down the road.

Guideline #5: Re-engineer the trading and treasury platform to balance the potential benefits of enhancing "reach" and "range".

Keen's notions of "reach" and "range" are useful here (Keen, 1991; Keen, 1993). Just-in-time functionality on the trading platform is aimed at enhancing range, by enabling information to be shared across the family of applications that enable an international bank to deliver trading and treasury services. For example, one of the goals of Salomon's re-engineering effort was to provide position information to traders across existing incompatible systems (Schmerken, 1991). The business value of current information is evident in so many ways: in rational pricing, in arbitrage identification and programmed trading, in real-time position risk management, and intra-day funds control for trading customers. The benefits are spread across the pre-trade, trade execution and post-trade processes.

It also makes sense to make investments that enhance reach, that is, enabling your systems to deliver their services to "anyone anywhere". For example, some of the pre-trade activity aimed at prospecting for new clients and identifying counterparties to trades, and interest rate and currency swaps could be enhanced by enabling customers to "connect" to the pre-trade system and post information about instruments in which they might be interested. (The logical extension to this idea is a third-party electronic market for a broader array of treasury services, which would create a major challenge to commercial bank servicing, in the same way that the new electronic securities markets are creating concerns among the old guard at the American and New York Stock Exchanges.) The goal here should be to support the process of more efficiently finding hedging and complex trading transaction counter-parties, and to establish first mover advantages by enhancing reach using the IT platform. Post-trade systems, where information is communicated to the debit and credit parties in trading transactions, and funds transfers are made, require seamless links to other bank operating systems including: databases that feed treasury management workstations deployed in corporate treasurers' offices, and the transaction advice and funds movement systems.

Guideline #6: In the absence of certainty about rapidly evolving industry standards for hardware, software and other related concerns, re-engineer to build a viable and broad "base" to hedge your bets in the "market for standards".

As the industry press and knowledgeable observers suggest (Slater, 1993), the standards in trading and treasury operations, unlike check processing and electronic funds transfer, have yet to emerge. As a result, there is really no such thing as an "open system", and senior managers invariably have to gamble on which hardware vendors have the staying power, which technologies will reach critical mass in installed base, and which software packages will emerge as the industry choices.

The solution here is to keep investing in the broadening base of technologies that will define open systems five years from today: SNA and OSI at the network level, TCP/IP at the LAN level, client-server systems, SQL server databases, X.400 mail, and so on. The general guideline for management in deciding whether a base technology should be invested in is whether there is a reasonable expectation that the installed base will reach critical mass in the near future, if it has not reached that point already. This leads to a related recommendation:

Guideline #6: The main issue is balancing timing and risk: committing to a standard or platform too early entails unacceptable technical, organizational and market risks; committing too late can mean certain failure if "functionality risks" make it impossible to compete.

The costs of dealing with the failure of an infrastructure technology in treasury and trading, like an on-line transaction processing system failure, can be staggering. For example, the recent explosion in the World Trade Center shut down the money market activities of many foreign banks located there (Iida, 1993a; Iida, 1993b). Reliability and fail-safe backups, however, are expensive. The obvious solution to this problem is to build in redundancy, both on-site and off-site, and re-engineer to enable a smooth transition that will sustain operating capabilities in the event of business disruption. Maintaining service capabilities in the money market in the event of a failure is crucial, and the potential adverse effects of any disruption are only compounded by the tight cross-market, cross-border and cross-time zone linkages that are at the heart of the international banking business.

CONCLUSION

Knowing how much to invest in information technology and re-engineering, and how to invest it, is a difficult decision for senior managers in the financial services industry. Doing cost/benefit analyses for individual applications can overlook integration and connectivity problems which invariably after the individual applications have been developed. On the one hand, trying to evaluate infrastructure investments is difficult since they often lead to yet unforeseen benefits; on the other hand, justifying infrastructure investments by hoping that they will lead to benefits down the line is naive.

We have provided some structure to this decision in treasury and trading operations in three ways. First, breaking down the process into three sub-phases delineates the various activities involved and how they are carried out. In deciding whether and how to re-engineer, management must ask itself which sub-process it wants to concentrate its resource on. Re-engineering pre-trade processes will result in satisfying a customer's needs better. Errors and reaction time will decrease if management concentrates on redesigning trade execution processes. Re-engineering post-trade processes can improve customer satisfaction as customer inquiries can be answered in real-time, and can improve risk management as instrument, customer, and market exposures can be calculated more and more frequently, towards real-time calculation.

Second, examining the technology platform will reveal the sophistication of the existing system, and the extent of the re-engineering that will need to take place to meet management's goals. For example, the move to real-time decision-making requires faster hardware: is a supercomputer necessary, or will a network of workstations suffice? In addition, senior managers need to decide whether they want to develop their own proprietary systems, or buy an open system. Regarding telecommunications, Regarding data feeds, a firm may have an video data feed coming in, but want a digital data feed, so that it can process the information with its own systems.

Third, using a re-engineering action leverage matrix highlights some of the variables that management has control over to change. These variables include the prices and quantities of the inputs and outputs. The matrix highlights price recovery margins and productivity metrics, as well as the usual accounting metrics of changes in revenues and production costs.

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Table 1: Foreign Exchange Trading Income of Major U.S. Banks

Money Center Banks	1979 ($MM)	1988 ($MM)	Increase (%)
Bank of America	90.2	122.0	40
Bankers Trust	16.6	153.9	830
Chase Manhattan	77.0	249.7	230
Chemical	9.9	143.2	1350
Citibank	113.6	616.0	440
First Chicago	11.2	148.6	1230
Manufacturers Hanover	16.1	103.0	540
J.P. Morgan	35.9	186.8	420

Source: Adapted from Smith and Walter, 1990, p. 350.

Table 2: U.S. Commercial Banks' Wholesale Systems Expenses by Line of Business, 1988

Line of Business	% of Total
Transaction Accounts	43
Trading (i.e. $954 million)	18
Lending	15
Funds Transfer	5
Cash Management	4
Information Services	4
Master Trust / Custody	2
Stock Transfer & Corporate Trust	2
Other	7
Total (= $5.3 Billion)	100%

Source: Steiner and Teixeira, 1990, p. 80.

Table 3: Key Actors in the Trading Process

Processes	Key Actors
Pre-Trade	lending officer, credit officer, treasury product specialist, customer, trader
Trade Execution	customer, trader, counterparty, order taker
Post-Trade	risk manager, funds transfer manager, customer service representative,

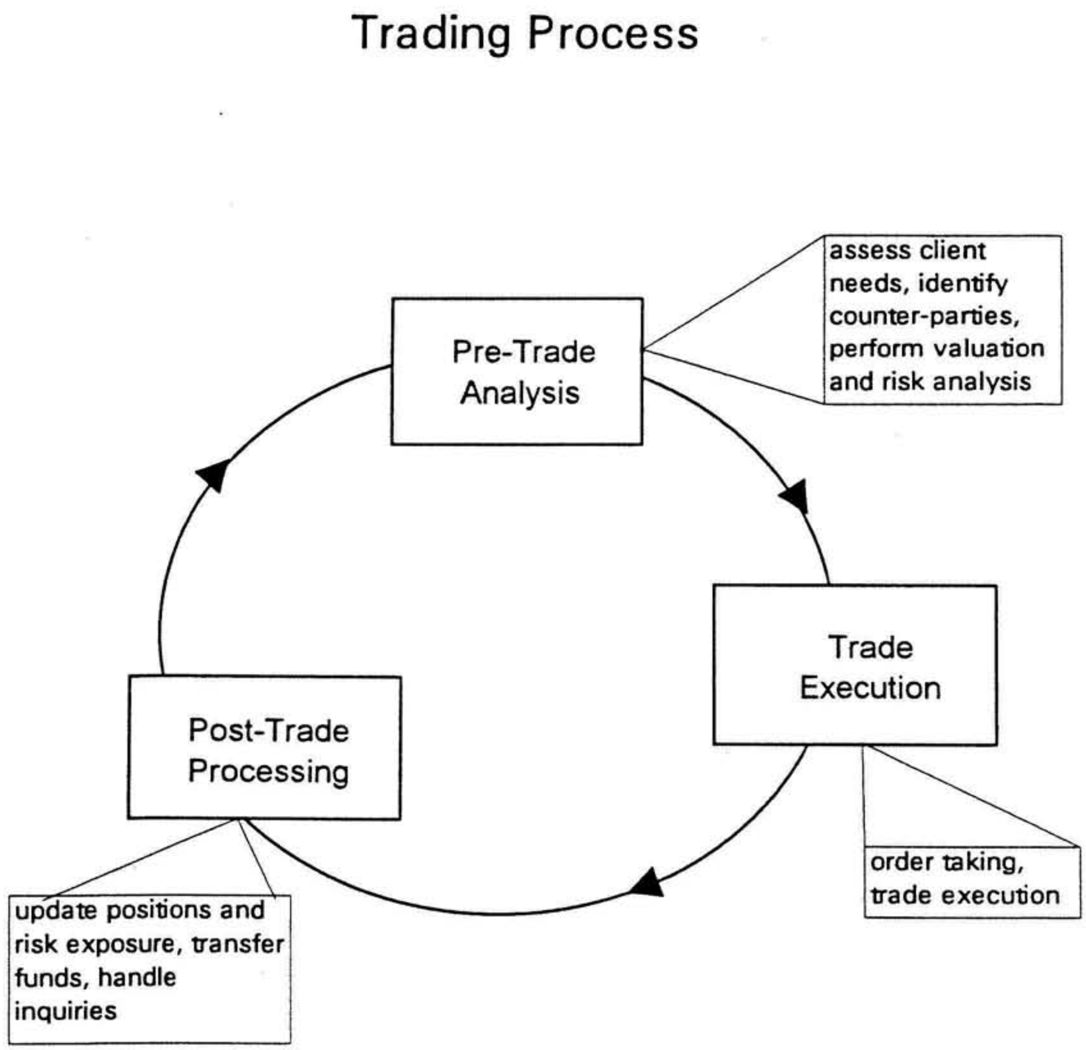

Figure 1: Trading Process Information Flow

Figure 2: Telerate Page of Data

WORLD SPOT CURRENCY MARKET COPR 1989 TELERATE PAGE 263
[LAST FIVE UPDATES IN EACH CURRENCY]

PAGE	BANK		YEN		GMT
3352	D G BANK	FFT	144.05	-15	16:53
3893	NAT WEST	LDN	144.05	-15	16:51
6252	BERGEN BK	BER	144.00	-10	16:51
3150	RBC	TOR	144.05	-15	16:51
3518	UBS	ZUR	144.00	-10	16:50
HI	0:25 144.73-		143.95	14:52	LO
PAGE	BANK		DMK		GMT
9330	ANDELSBANK	COP	1.6685	-92	16:53
3327	AKTIVBANK	VEJ	1.6682	-89	16:53
3540	CR SUISSE	ZUR	1.6675	-85	16:53
3150	R B C	TOR	1.6670	-80	16:53
3552	D G BANK	FFT	1.6680	-90	16:53
HI	0:13 1.6950-		1.6645	14:52	LO

NEW TTS USERS: MIDLAND, HAMBROS, CHASE NY,RABOBK UTRECHT, CA LYON PAR,MBISHI NY
01/08 11:41 TREASURY ANNOUNCES TAX AND LOAN CALLS, RESULTS 4142
01/08 11:42 =GILTS: CONFUSION ON BUYBACKS RESURRECTS MARKET JITTERS . . .4234
01/08 11:45 GILTS ENDING ON 3/4 AMID CONFUSION OVER GILTS BUY-IN POLICY . . 4158
01/08 11:46 STOCKS MOSTLY LOWER AS MARKET DRIFTS: DJIA UNCHANGED 4116
01/08 11:47 NYMEX 1989 TRADING VOLUME -2-: PLATINUM VOLUME OFF 13 . . . 31785
01/08 11:49 OAPEC SAYS COOPERATION WITH EC PROMOTES EURO-ARAB TIES . . . 31825

Source: Waters Information Services, 1991

Figure 3. American Productivity Center Profit Variance Matrix Applied to Classify Re-engineering Business Value Levers