Managing Risk with Composite Information Systems

Ying-Sung Tay

May 1990 WP # CIS-90-10

MANAGING RISK WITH COMPOSITE INFORMATION SYSTEMS

Ying-Sung Tay

May 31, 1990

Research Assistantship Report

ABSTRACT

With huge exposures, potential corporate-wide damages, and high volatility like those in contemporary financial markets, risk management is increasingly becoming a major concern among financial and non-financial firms today. This paper presents the case for the use of composite information systems in managing exposure to risks, especially in the context of financial institutions.

Corporations and financial institutions face a wide variety of risks in their daily operations. The objective of risk management is to maintain the firm's exposure to these risks within acceptable bounds. In this paper, we assume that what constitutes "acceptability" has been set by management; we concentrate on what how a firm can manage its exposure by better understanding information gleaned by disparate data sources. We begin with an overview of contemporary risk management: what are the different kinds of risk and what are the sources of each kind, how companies organize themselves for risk management, what are the benefits of an information system for risk management, and requirements for such a system, and the kinds of risk management systems deployed today. I will also briefly describe the kinds of multiple-source information systems currently in use for risk management, and the trends in the vendors of these systems in merging among themselves. The balance of this paper examines the case of Salomon Brothers–how it organizes itself for risk management, the risk management systems in place, and how Salomon Brothers might use new techniques in composite information systems to better organize itself for risk management.

KEYWORDS AND PHRASES: risk management, exposure, heterogeneous databases, integration, information systems, Salomon Brothers.

ACKNOWLEDGEMENTS: I would like to thank Professors Stuart Madnick and Richard Wang for their support in this work. Many people at Salomon Brothers have contributed to this paper. I thank them all. Support for this project was provided in part by the MIT International Financial Services Research Center.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

In 1987, Merrill Lynch reported a $377 million loss in the mortgage-backed securities market. This was primarily due to an oversight in risk management. In 1988, First Boston estimated a pre-tax loss of as much as $50 million in the same market. Again, this was due to poor risk management.

"In London's Big Bang, newly merged institutions have found themselves the proud possessors of millions of pounds' worth of high technology systems which are uniformly incompatible. When the branch is in a different time zone from the one the head office is in, has a dissimilar risk-management policy, and has fostered a spirit of local autonomy, communications can deteriorate to the point where ignorance results in vulnerable exposures."[1]

In January 1990, interest rate increases in West Germany and Japan sent shock waves through the U.S. stock and bond markets. Because the U.S. Treasury Department must borrow to fund its huge deficit, the U.S. has become a debtor nation dependent on foreign capital. Japanese institutions purchase one-third of the U.S. Treasury bond issues, and there have been fears that U.S. interest rates will have to increase to attract Japanese investors.

With huge exposures. potential corporate-wide damages, and high volatility like the situations described above, risk management is increasingly becoming a major concern among financial and non-financial firms today. This paper presents the case for the use of composite information systems in managing exposure to risks, especially in the context of financial institutions.

Corporations and financial institutions face a wide variety of risks in their daily operations. The objective of risk management is to maintain the firm's exposure to these risks within acceptable bounds. In this paper, we assume that what constitutes "acceptability" has been set by management; we concentrate on what how a firm can manage its exposure by better understanding information gleaned by disparate data sources. We begin with an overview of contemporary risk management: what are the different kinds of risk and what are the sources of each kind, how companies organize themselves for risk management, what are the benefits of an information system for risk management, and requirements for such a system, and the kinds of risk management systems deployed today. I will also briefly describe the kinds of multiple-source information systems currently in use for risk management, and the trends in the vendors of these systems in merging among themselves. The balance of this paper examines the case of Salomon Brothers–how it organizes itself for risk management, the risk management systems in place, and how Salomon Brothers might use new techniques in composite information systems to better organize itself for risk management.

1. AN OVERVIEW OF RISK MANAGEMENT

We begin by examining the various aspects of risks faced by today's financial institutions. We then discuss how companies organize themselves for risk management, how the organization utilize information systems for risk management, and the major problems faced in risk management.

---

1 "Keep Risk at Bay in the Global Banking Era," Euromoney, January 1987, pg. 70.

1.1 The Context of Risk Management

The typical firm faces many challenges in its management of risks. These changes come from many contexts:

Source	Characteristics and Examples
competitive context	globalization, regionalization, competitive parity
macro economy	chaos, turbulence, imbalances
government role	fiscal policy, industrial policy, protectionism, rollback of scope due to fiscal limitations
financial markets	globalization, volatility, innovation, continued credit and country risks
technology	increased pace, open learning loop, technoparity

Table 1: The context of risk.

The above characteristics and examples represent the perils of today's environment. Yet, this same environment offers much potential for profits. For instance, one of the most profitable areas for bank expansion is *global Capital market trading*. Chase Manhattan had trading revenues of $233 million in 1987; Citicorp–the number one among trading banks–posted $453 million in the same year; Bankers Trust reported whopping gains of $338 million in the last quarter of 1987 alone. All three are heavy global traders.

The *proliferation of information sources*, however, comes with global activity. For example, the Association of International Bond Dealers (AIBD) has a settlement system called ACE (for AIBD, Cedel, and Euroclear) offering next-day confirmation, as well as TRAX, a trade matching and confirm system that may also carry real-time price information. The International Stock Exchange of London is in the middle of several new systems developments designed to eradicate confirmation and settlement problems. SEQUAL is its on-line trade confirmation system for international equities. The London exchange also has a Transfer and Automated Registration of Uncertificated Stock (TAURUS) to take paperwork out of settlement by enabling member firms to hold and transfer securities without the need for share certificates. At the Chicago Mercantile Exchange, the Post Market Trading (PMT) system is being expanded from currency and interest rate futures contracts to stock exchange and index futures.

And finally, there are the *digital feeds* from Reuters through its Rich and Triarch products, as well as Micrognosis, Quotron, Datalogic, Bishopsgate, and other commercial information sources, all contributing to the proliferation of information sources.

The current situation is also filled with *sundry unintegrated in-house risk management systems* and *global networking facilities* provided by vendors like General Electric Information Services and IP Sharp. But these have again been unintegrated, stand-alone services which operate in batch and often require separate keying by back-office staff after the trade is closed by front-office traders. Some banks have over five trading systems in operation simultaneously, creating over 10,000 positions per day. However, most of these systems are not integrated.

Any bank with a range of services would need to link to these systems. At the same time, it must also be able to know its risk position for different financial instruments at any time. Not only is this knowledge useful for its risk management, it is required by many regulatory agencies such as the Bank of England (BoE), the Securities Association (TSA), the Federal Reserve Bank (Fed), the stock exchange, or international bodies like the AIBD. Financial institutions have no choice but to comply if they want to remain active. Not only do

they have no choice in compliance, they have to submit *compliance reports* frequently and regularly. For instance, the TSA demands fortnightly position risk reports–counter-party risk requirements (CRR), position risk requirements (PRR), etc. Further, there are in-house reporting which audit the trading activities for control purposes.

Information supplier	Terminals	Sites	Average per site	Penetration of dealing rooms (%)	Percentage of positions	Ranking by positions
Reuters	5,799	195	30.5	97.5	31.4	1
Telerate	4,087	142	29.8	71.0	22.1	2
Topic	3,350	49	71.3	24.5	18.2	3
Datastream	1,150	30	42.6	15.0	6.2	4
Knight-Ridder	313	23	14.9	11.5	1.7	8
Bloomberg	74	13	5.7	6.5	0.4	
Futrend	63	12	5.3	6.0	0.3	
Quick	949	11	105.4	5.5	5.1	5
Quotron	928	11	84.4	5.5	5.0	6
Bridge/Point	26	10	2.9	5.0	0.1	
ADP Comtrend	17	9	2.1	4.5	0.1	
Extel	702	3	234.0	1.5	3.8	7

Table 2: List of Information suppliers and their market shares[2].

The information requirements for risk management has also changed over time. Traditionally, network operators like IP Sharp and GEISCO have sold specialized, stand-alone global-limits systems for the setting and manipulation of exposures to counterparties. The significance of these has waned quickly. For one thing, they only provide information on counterparty exposure. Now that credit risk has been monitored, most banks turn their attention to managing market risk–the risks due to interest rate, currency, and liquidity fluctuations, whose volatilities have increased significantly over the years.

Therefore, the *sources of risk-management systems have shifted from credit managers to traders.* Even then, companies like Salomon Brothers have accommodated such shifts by coordinating trading activities centrally with a degree of autonomy in each geographic area. The rationale usually given for such a structure, as opposed to a centralized system, is that it is hard to create a formalized system of limits and positions because the conditions governing what they should be can vary very fast–it is more a question of keeping up a continuous dialogue between the risk manager and the trader.

1.2 The Many Types of Risks

A typical firm faces risks originating from the *individual counterparties* they deal with (*e.g.* suppliers and customers), the larger *economic environment* (or the market) in which they operate, , the *political and regulatory environment,* the still larger *international environment,* and even *internally* from the firm itself (please see Figure 1).[3]

---

2 Source: "How to Tame the High-Tech Monster," *EUROtec,* August 1988, pg. 33.

3 Adapted from "Managing a risky business," *Banking Technology,* November 1989, pp. 25-27. The article did not make the distinction of the international environment.

Counterparties are the sources of the following kinds of risks:

- *settlement or clearance*: customers may delay settling accounts receivables (or even not settle such receivables if they go bankrupt) and suppliers may shorten the grace period for settling accounts payable.

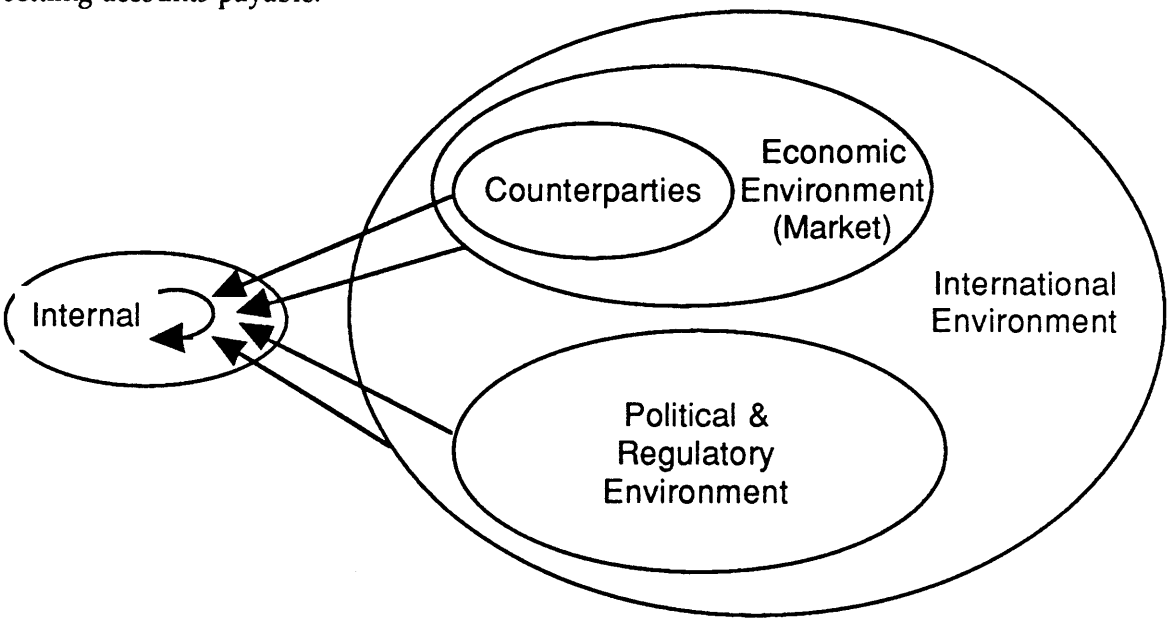

Figure 1: The sources of risk.

- *credit:* the credit ratings of customers and companies vary according to their financial performance over time. The changing credit worthiness would affect the credit lines extended to the customer, their equity ratings and their corporate debts' ratings.

- *mergers, and acquisitions*: some companies may have their credit ratings reduced due to poor acquisitions. For instance, if one has stocks of Volkswagen of Germany and is not aware of the latest Brazilian economic policy and restrictions on repatriation of dividends, one would miss the story on Autolation, a joint venture Volkswagen has with Ford in Brazil and Argentina. Unfortunately, for someone to watch for events in Brazil even part-time is too much a waste of resources because the recourse to information on Brazil is so infrequent. However, when one does need the recourse, it is usually of utmost importance because Autolation, for example, is a big subsidiary of Volkswagen and can make a big difference to Volkswagen's global results.

The larger economic environment has the following kinds of risks:

- *interest rates*: changes in interest rates drastically affect the ability of borrowers to repay and lenders to recuperate their loans.
  - *yields*: yields are a rough measure of the return on financial instruments like bonds.
  - *basis*: a basis point is a hundredth of a percentage point of some index (*e.g.* the Dow Jones Industrial Average). Changes in basis points affect a range of corporate activity such as share issues, takeovers and mergers, and stock valuation.

- *liquidity*: this is the convenience with which a company can sell its assets. Changes in liquidity would require changes in the composition of assets that the company should optimally hold.

The political and regulatory environment is another important source of risks:

- *political changes*: these can affect the general economic philosophy of the government, through fiscal and monetary policies, for instance. These government activities in turn affect the firm's exposure to other kinds of risks (*e.g.* interest rates).

- *regulatory changes*: these can in turn affect the exposure of the firm to other kinds of risks like interest rate risks and cost of financial intermediation. For example, the recent regulation for all Saving and Loans association to liquidate their junk bond holdings has dramatically increase the volatility and reduce profitability of the high yield bond market participants.

- *capital requirements*: financial intermediaries are required by law to conform to certain capital requirements as collateral for lending. Changes in these requirements will affect the costs of financial intermediation.

As most financial institutions operate in an international environment, additional risks are involved:

- *exchange rates*: changes in exchange rates can have potentially large impacts on the profitability of overseas operations. For instance, there is a strong negative correlation for U.S. investors in Dutch equities. The big Dutch companies sell their products priced in dollars. However, their shares are priced in guilders, and the companies are so large they dominate the Dutch financial market and economy. If the dollar goes up, the guilder goes down. So although the share price may increase as the companies sell more for dollars, their very success drives down the guilder. The U.S. investor loses his equity gain in the new exchange rate.

- *country*: different countries have different risk profiles, and financial institutions should be aware of them. The recent Latin American debt crisis is an example.

Finally, even the internal operations of the firm are sources of risks:

- *systems failure*: these can quite easily cripple the operation of the information-intensive financial institutions.
- *fraud*: insider trading at security houses is an example.
- *human error* in entering details of the transactions that leads to incorrect assessment of risk positions.
- *information integrity* is difficult to maintain when are duplication of the same instance of the data all over the organization.

All the above types of risks interact with one another. For instance, credit risk of corporate (especially junk) bonds increase when market risk (*e.g.* Treasury rates) increase. Higher interest rates may also affect various macro variables, such as exchange rates.

1.3 Organizing for Risk Management

Given the backdrop and many types of risks, how do financial institutions organize themselves to cope with risk? There are three aspects to this organization, and we will discuss them in turn. The three aspects are:

- the structure of the organization,
- the function and policies in the organization, and
- the risk monitoring systems in the organization.

The difficulty in seeking to control intra-day exposures is that for the information to be worthwhile, it has to be genuinely up-to-the-minute. But getting transaction information from the focal points of today's far-flung banking empires remains a stiff task and beyond the capabilities of most banks. The trouble is, even as the drive toward centrally controlled exposure and liquidity management gathers pace, there is a similar momentum the other way: the decentralization of most decision-making, due to increased complexity and pace of financial markets. Trading desks have replaced executive suites as the decisive nodes in the major banks' policy-making structures, and as the sources of the transaction data any risk-management system would need to trawl together. As one Salomon Brothers' foreign exchange director puts it: "None of us even has an office any more. We work on the floor all the time–managing the positions, pricing, everything. It's called in-the-aisles management."

Most companies have a *structure* of risk committees and key individuals, which allocates clearly defined responsibilities for managing the companies' exposure to these risks across all geographical locations and business areas. A key step in structuring a risk management organization is to establish a dedicated risk management function. Within this function there should be designated individuals whose responsibilities extend to all existing and new types of risk. The risk function should have global reach and may coordinate an array of risk committees involving specialists in areas such as credit, interest rates, foreign exchange, equities, bonds, and derivative products (like options and swaps). The precise nature of this function must be consistent with the overall business philosophy - for example, if there is generally a decentralized management approach then the risk function could also be decentralized. However, in all cases, there should be a "center of excellence" which retains ultimate responsibility for global risk management and which is to some extend independent from the trading areas.

Policies and *limits* quantify those levels of operations which may acceptably be carried out by the companies' executives. This requires a hierarchy of limits to reflect the strategic, tactical, and operational levels of management. A balance needs to be struck between ensuring that the business operates in a controlled manner, while allowing the firm's officers the flexibility to meet return-on-capital goals. Financial institutions are increasingly using a more formal approach to establishing limits. This approach reflects both the perceived likelihood of loss from individual deals or groups of deals, and the capital which the institution is prepared to put at risk.

The likelihood of loss from trading positions depends upon the following factors: the volatility of key reference rates (*e.g.* interest and foreign exchange rates), responsiveness of the dealers and of the positions to change in the reference rates, and the liquidity or the ability to close the position quickly in the event of an adverse movement in rates or prices.

These factors can be estimated, in the first instance, from a statistical analysis of historical rates and dealers' performance. However, it is essential that such historical perspectives are regularly reviewed in the light of constantly changing market conditions. For this reason some financial institutions rely on the dealers to determine appropriate trading

levels. The traders are usually in the best position to appreciate the market conditions at the time of each deal.

The treasury and capital markets units of international banks are increasingly trading portfolios of a mix of on-balance sheet (*e.g.* bonds) and off-balance sheet (*e.g.* swaps and options) financial instruments. They must therefore be able to assess the risk exposure of the net portfolio. For example, a fixed for floating interest rate swap could transform a fixed rate long term bond to a floating rate long term bond when viewed as a composite financial instrument. Being a floating rate bond, it is less susceptible to interest rate fluctuations. If these two instruments are viewed as independent transactions, they are portraying a different risk profile. Many banks are frustrated from achieving this goal by a proliferation of computer hardware and software systems, which individually process only a small number of product-types.

A number of swaps trading units have developed a generic approach which enables virtually any financial instrument to be mathematically modelled as a series of common events, essentially cash flows. The effect of movements in volatility and interest rates, the slope of the yield curve, or the spreads between different instruments can be be computed by calculating the present values of the cash flows using appropriate zero coupon yield curves. Some banks now use the measure labelled "Price Value of a one Basis Point shift" (PVBP) to monitor the sensitivity of the portfolio to such movements. Generic approaches could be extended across many areas of a financial institution to provide a global methodology for measuring, and ultimately controlling, its worldwide exposures to these types of risks.

Once these risk-related issues have been addressed, the financial institution then faces the problem of developing appropriate *risk monitoring systems*. Such systems, predominantly computerized systems which enable the responsible individuals at appropriate levels of the institution's risk organization to monitor the actual business against these policies and limits at all times. The risk monitoring systems are the bedrock of the risk management framework. They must be developed in the context of the companies' international risk profile and the structure of their risk policies and limits. Individual companies will differ in their business philosophies, and therefore the way in which they allocate responsibilities for managing risk. There is consequently a wide diversity in the nature of these monitoring systems.

The first hurdle to overcome is often the failure to develop a global information technology strategy. This results in a lack of consistency of computer hardware and software both within and between geographical locations. It is therefore impossible to integrate consistent, accurate, and relevant risk information on a timely (preferably real-time) basis. This problem can be exacerbated by a failure to include risk management information requirements in the specification of the underlying transaction-processing systems and the lack of control over the interfaces with external information sources.

In a decentralized environment this strategy problem can be overcome, at least in part, by defining global corporate data standards for risk management information. The resulting information can then, if necessary, be consolidated centrally for the purposes of reporting to the head of the risk management function. Software tool kits, such as the Risk Data Consolidation System (RDCS) developed by Cumulus Systems Limited of the UK for a DEC Vax environment, can be used to draw such information from a variety of computer hardware and software systems.

In a centralized environment there is an increased requirement for large central databases of transaction-level information. However, the ambitions of some financial institutions to build such systems in-house, to cover all conceivable global banking products and services, have often been frustrated by their high cost and complexity. There is now a trend to

restrict such developments to more-limited business ares, within a global framework of data and systems standards.

The second challenge faced by many financial institutions is to manage the transition from a variety of systems, which have evolved over a long period of time, to an integrated systems architecture for risk monitoring purposes. In the trading areas of many financial institutions these systems are entirely separate, despite the fact that the transaction-processing and risk monitoring functionality of both are often very similar. In the absence of an integrated system, with one-time input for each deal, there may be wasteful duplication of effort and a lack of consistency of risk-related information between the two systems. The ideal and most efficient architecture for these systems is one which uses a common database of transaction-level data to drive all front office, back office, and risk monitoring needs (please see Figure 2). This architecture helps to bind together the various departments and data sources involved in risk management. It also generates a "middle office" which has primary responsibility for ensuring the quality of the transaction-level database and of the risk information used in all areas of the financial institution.

However, most financial institutions today cannot realize an ideal architecture such as that in Figure 2. Just the number of research and news sources already overwhelms the management of risk. Consider the following kinds of information that risk management systems have to consider:

- *quotations*. The quotation business is now more than a few billion dollars in size. Table 2 earlier shows the major players.

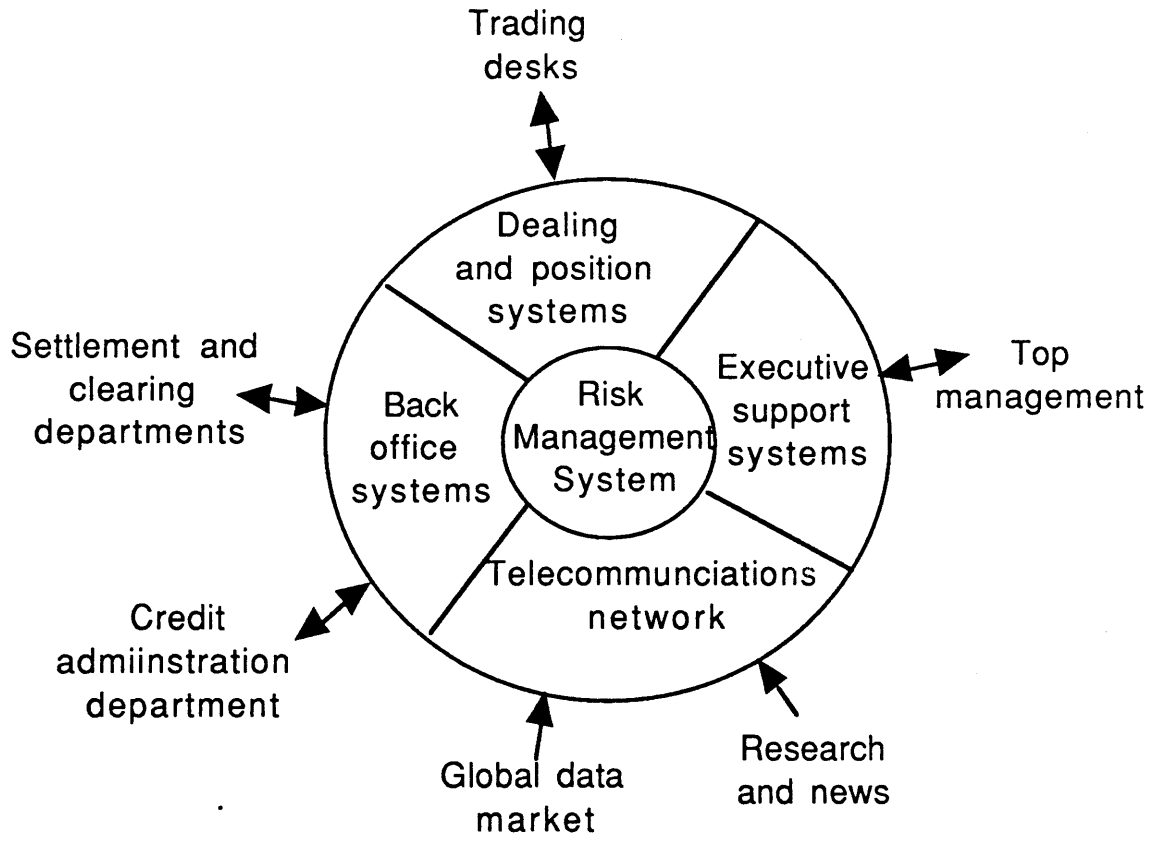

Figure 2: An ideal, centralized architecture for a risk management system.

- *data collection*. There are five major categories in this sector:

  - *corporate financial information* about companies' balance sheets and income statements, SEC reports, industry information, and historical financial performance. Some of the vendors in this are include Disclosure, Florida-based Q Data, Standard & Poor's Compustat service, Dow Jones's news service, and importantly, internal programs operating at most major institutions.

  - *environmental information* which includes econometric information provided by firms such as Data Resources, Chase Econometrics, Townsend-Greenspan and scores of others that are now available to essentially anyone through on-line database systems. One important thing to remember, however, is that *no carrier or computer will tell you which service is accurate.*

  - *competitive information* provides information about activities of different brokerage firms and banks in the financial markets and includes rankings of their competitive performance and listings of various categories of leadership, such as performance of their offerings in the after-market. Suppliers of these services include Investment Dealers' Digest, Securities Data (a subsidiary of Capital Cities Communications), Standard & Poor's MarketScope service, two services provided on Telerate and many other. Again, most major brokerage houses also do their own internal analysis.

  - *securities information* answers questions such as who owns what, who's buying what, institutional interest in particular securities and what securities companies have offered for sale. Two of the leading vendors are Computer Directions (Baltimore) and H.F. Pearson (N.Y.).

  - *financial news* is available both selectively and through broad tape mechanisms. The obvious suppliers are the Dow Jones broad tape, Dow Jones News Retrieval, Reuters, and most quotation services.

- *opinion vending*. If you want information from the investment newsletters, economic advisors, or research analysts or just about anyone else who is influential, you just have to press a few buttons. Through news networks such as NewsNet, ADP's network services or several other ones, you can find out what Value Line thinks of a particular company or what a research analyst has said in the Wall Street Transcript or what Fed Watch thinks the money supply figures will be, or earnings estimates from Lynch, Jones & Ryan.

- *analysis*. Suppose you have a particular problem besides an investment decision and you want the data analyzed and an answer provided. By combining services offered by firms such as Data Resources, Chase Econometrics, and ADP, with software by outfits such as Lotus, VisiCorp, Context MBA, and MultiSoft, you can start with a hypothetical methodology and bring it to its logical end by accessing data that the database searches for with only the most general specifications. The computer then downloads this data into an integrated spreadsheet program that helps provide the answer.

- *executive services*. Once you have all the answers both for your firm and for your customers, you want to make something happen, that is, create business. If you happen to be a brokerage house, you can now feed all this data to your customers, and they can call back your computer with an order. You can then take this order, or orders where you are a principal, and get instant guaranteed execution through some exchanges and

through services such as Instinet. After execution the trade can then be cleared through a similar type of black box arrangement.

The above range of information sources are used in most financial institutions, and there are the same sources that risk management systems rely on.

Another dimension that drives the decision of what sources to have and use is control. Many smaller firms and some of the larger ones have been less concerned about control and have allowed their brokers, analysts, loan officers, etc. to make their own equipment and database decisions. In this case, with the general exception of quotations, the user pays the bill instead of the corporation. This obviously saves money for the corporation and importantly, allows an employee to purchase the service that will best benefit productivity. The companies that allow this approach and are successful have set up advisory services to help users formulate plans and ideas as well as to monitor user activity and thus minimize the control risk. This has created a spirit of cooperation which has improved employee relationships while maintaining the entrepreneurial spirit that drives much of this industry.

One firm that has done a fine job in this area is Merrill Lynch, but we now know that its controls were not sufficient for risk management. The Merrill Lynch approach has important advantages. It lets the individual "do his own thing" while guiding him or her in the right direction. There is nothing wrong with brokers buying personal computers and accessing internal or external databases and the like as long as someone can help them decide what products are best suited for their needs, help train them, and use the buying power of the organization to save them money and time. The *quid pro quo* is that the brokers will act in a professional manner and follow the guidelines mandate by the organization. Before the Merrill Lynch loss in 1987, some even say that with this approach, "the corporation entertains no more control risk than it already accepts by giving its employees telephones." And of course, this turns out to be false.

Software suppliers have identified a gap in the market, pending completion of development by some banks of their own systems to handle the more exotic financial instruments. Application packages such as EMS, developed by Devon Systems, and Cmark from Quotient, address the enema of managing risks across the range of instruments which are typically traded by banks' swaps units, for example.

A key feature of the newer systems is the ability to measure the counterparty credit risk associated with off-balance sheet instruments. This involves monitoring the loss which could be incurred by the institution if the counter party defaulted. In such instances, the loss would be the cost of replacing the deal in the market at prevailing rates. There is consequently a need to constantly update the credit exposure as market rates change. Any bank which doubt the importance of this facility should consider the unenviable situation of institutions which have swap contracts outstanding with local authorities and building societies, or option contracts outstanding with private individuals.

The scope of risk management systems can be extended to cover not only the monitoring of risk positions but also the reporting of daily profits and losses. Daily profit and loss reports, based on regular revaluations of open positions, help traders in verifying their positions. In addition, it also enable senior management to identify trading problems at a relative early stage.

Institutions can also take the additional step of evaluating performance in relation to the actual level of risk exposure. This measure introduces the concept of risk-adjusted profitability which involves comparing profits and losses to the level of risk (and hence risk

capital) incurred. The requirement can be incorporated within the specification of the risk monitoring system.

Another trend in risk management systems is to go beyond monitoring to modelling. A few of such modelling systems exist now, but the information is usually not sufficient in quantity or timely enough.

It is clear that most executives do not expect or believe there should be a standardized system. "An external interest rate system should be standard so that everyone has standard formats. It would make interest rates easier to track. But processing has to be customized. International mutual funds are totally different from bank pension funds, for example."[4]

More than most organizations, banks and securities houses have to address an increasingly wide range of risks. Some financial institutions have historically concentrated upon standard lending or credit risk. They have therefore failed to manage adequately the more complicated market and counterparty risks associated with recent advances such as swaps and options.

1.4 Benefits of Risk Management Systems

Some of the benefits of risk management systems have been mentioned earlier. We now recapitulate these benefits as well as elaborating on some additional ones.

The primary benefit of a risk management system is to focus the resources of the financial institution on its best clients. Without a risk management system, traders and other lenders may be lending beyond their credit limit for the borrower. Similarly and for the lack of sufficient information, traders may be overly conservative, lending less than they could. With sufficient information, financial institutions can "double, triple, or quadruple volume" without adding trading staff.[5] This is point reflects the classic tradeoff between risk reduction (or hedging) and responsiveness. A company needs to be responsive, but responsiveness means decentralization because expertise required for responsive actions are distributed throughout the company. However, distributed responsiveness makes risk reduction difficult because risk reduction requires centralized capture of information.

From a senior manager's perspective, a risk management system allows him or her to monitor the type, size, and results of the traders' bets. With such information, they can order changes or question trading moves without interrupting trading activity to extract information.

Another benefit of risk management system is to cancel out redundant deals. For instance, a New York trader may take hedge positions that duplicates a Tokyo position. A risk management system provides information on such redundant deals, saving the company the commissions and internal processing of the unnecessary deals. However, it is generally recognized that the amounts of the commissions relative to those of the deals are insignificant.[6] Further, the marginal savings achieved may not be sufficient to warrant the additional co-ordination between the traders, which may not be feasible in very volatile markets.

---

4 Brennan, Peter J. "Portfolio Managers Weather Global Risk Management Challenge," *Wall Street Computer Review*, October 1989, pg. 53.

5 Marion, Larry. "Creating a Global Outlook," *Institutional Investor*, March 1987, pg. 232.

6 Marion, Larry. *ibid.*

A final benefit of risk management systems come from its centralized nature. Traders and clerks entering the transactions into systems equipped with built-in global-limit monitors could be more efficient. The number of back-office employees required to support trading activity may also be reduced.

1.5 Technological Requirements for a Risk Management System

With the above in mind, we can lay out the requirements for an ideal risk management system.

- be *real-time*. Frequency of risk management depends on the liquidity and volatility of the market in question. For example, a daily position is more than suffice for most of the markets when there are no turbulence, and hourly or even up the minute positions may be necessary when there are turbulences. Further, the period of monitoring may also depend on the size of the position that the financial institution has taken. Since "real-time" is difficult to define, one can start by defining "real-time" to mean responding within a preset bound. A real-time system can provide the responsiveness inherently required for risk management. It would be even better if the periods for different markets could be easily modified for cater for different needs.

- can *dynamically allocate of capital and limits*. The dynamic setting of trading constraints help enforce limits on exposure. The ability is to not to eliminate it, but to assume and manage it in accordance with the bank's short-term and long-term resources. However, the benefits of dynamically allocating the limits may not justify the enormous resource requirement for a market that the financial institution is not too active in.

- *support a broad spectrum of analytical needs*. Facilities for simulation, sensitivity analysis, exposure calculations, and time series analysis are important in providing incentives for usage of the system. Just as important as the analytic is the trader's understanding of the computations involved. Many financial institutions are reluctant to get a black-box analytic program–the minimum must be an explanation of the algorithms involved in the computations.

- have a *suitable human-computer interfaces*. Complementing the analytical tools must be user-friendly interfaces that eliminate the hurdles for users in the actual use of the system.

- can be *realistically implemented, given the existing environment*. For instance, the trading rooms in many banks are more sophisticated than their back offices. Concepts like the "middle office" creates a buffer that can function as a database quote server or network manager, so that a bank can build the interfaces to an improved or new backroom operation over time when it is ready to be integrated into the total system.

- is *flexible*. Given today's volatile financial environment, risk management systems must be easily tailorable. For example, new sources of information must be easily integrated into the system. Salomon Brothers of London added an accounting database as an information source for its risk management system only in 1987, when the system has been running for many years. In the same year, Salomon Brothers also increased its paid-in capital for its Tokyo office by $300 million. This allows the company to be a major force in the Japanese financial market–it can trade yen bonds and yen equities the

way it trades securities elsewhere in the world.[7] With this increased financial commitment, the risk management system needs to accommodate yet another source of information. A risk management system should also be modular and robust, so that the failure of one source of information should not hamper the entire system.

- *support cross-product and application data.* For instance, a trader needs to perform split-second comparisons of different trading opportunities in order to select the best "buy" with the most limited risk. One of the problems with supporting cross-product and application data is the difficulty of assimilating information from disparate sources. This problem is especially intricate with international sources of information.

  Government policies, such as those concerning the filing of corporate reports, are highly inconsistent across national borders and pose a daunting challenge to database providers who aim at a uniform format for data feed. Further, such vendors are already facing problems with data supplied by third parties. Concerning security prices, for instance, the original supplier often does not maintain historical data with adjustments for all the corporate actions, including dividends, symbol, and CUSIP (Committee on Uniform Securities Identification Procedures) changes. Some sources like Reuter's IDN data feed compensate for such poverty in quality by providing historical information. Further, the over 200,000 instruments in IDB are identified with unique Reuter Instrument Code (RICs) so that one need not worry about SEDOL (stock exchange daily official list) numbers, CUSIP numbers, ticker symbols, and other security identification schemes. Other vendors combine their information sources for improved consistency. For instance, Telekurs (North America) Inc. of Stamford, Conn. and Standard & Poor's/McGraw-Hill jointly published the "International Securities Identification Directory." This directory establishes a standard nine-character security identification number called CINS, an acronym for CUSIP International Numbering System. Similarly, New York-based Knight-Ridder Financial Information also is going in for integration, but of its own products by combining its MoneyCenter and Tradecenter products. Dow Jones News/Retrieval plans to come up with a new on-line service next year called DowVision. It will be a composite pre-processed feed of five Dow Jones wire services and two from other vendors, initially sent over terrestrial lines. Today with overlapping financial markets, the line that separates one from the other is a very fine one.

1.6 Risk Management Systems Today

We will briefly describe a few risk-management systems in use today, and highlight their strengths and shortcomings[8].

Citicorp Investment Bank put considerable effort into building its Global Trader computer system. This is a real-time network using VAX 2000 workstations from Digital Equipment Corporation. The workstations are linked throughout the trading room using DEC NET and to Citicorp's worldwide communications systems using Ethernet. The bank's various trading software systems–such as Trestle, Dog Fox, Gems, and Global Reports–are linked to the Global Trader System. This system also offers on-line connections to the back office. The Global Trader System has been installed in London, Paris, Frankfurt, Tokyo, and Singapore. In each of these cases, software was not built on top of existing accounting or back-office systems. Instead, it is designed as a full-blown trading risk-management application.

---

7 "Salomon Sitting Next to Japan's Next Four," *Euromoney*, March 1987, pg. 145.

8 Various issues of the Wall Street Journal and Euromoney.

Bankers' Trust has an automated deal-entry and risk management system called Resources Management Online System (REMOS), which it jointly markets with DEC.

Finally, *Chemical Bank*'s risk management system runs on IBM System 38 computers. Like REMOS, this system was designed to support trading activities, and not just to book and process transactions. More importantly, Chemical Bank's system has real-time position-keeping capabilities, allowing senior management to gain an instant snapshot of the firm's risk exposure and profit and loss at all times.

At Wall Street's leading securities firms (as opposed to the commercial banks mentioned above) such as *Salomon Brothers*, such information is often only available at the end of the day when back-office clerks have keyed in the day's trading tickets into batch-processing computer systems. The problems begin early in the process when traders tend not to input the transactions completely, even when there is a real-time system to provide error detection at source. In fact, most trading transactions are currently completed not on computers but over the telephone. Book-keeping details that might offer company directors a sense of what is going on are completed much later. At Salomon Brothers, at the end of each day, trading positions are transmitted via facsimile across the ocean to its overseas offices–in an era when technology exists to pass the book or blotter electronically. Generally, the thinking goes that traders are hired to trade and clerks are there to record the transactions.

Since global risk management systems rely heavily on the integration of information, we next describe commercial implementations of information systems that feed data from multiple sources.

1.7 Multiple-source Information Systems Today

One multiple-source information system is the Global Report from Citicorp. The menu-driven service is expanding, and recent additions include incorporation of a Citicorp service called CitiMarkets, which covers the Asian financial world and includes graphics capabilities. Global Report also recently inaugurated a foreign exchange rates service; work is underway to integrate these services. The system has an index which allows users to retrieve information based on subject. It also allows users to get from a number of sources information on one company.

Worldscope is an ongoing project of the Center for International Financial Analysis and Research (CIFAR) in Princeton, N.J. and Wright Investors' Service, Bridgeport, Conn. It presents data from 24 countries and 27 industries in a uniform format which its human compilers assert will allow users to do "apples to apples" comparison for data from sources with different accounting practices, varying exchange rates, and numerical formats. Although a service such as Worldscope adjusts for disparate national accounting procedures, at least in theory, *not all potential users want the data that way.* Somebody who knew the French market extremely well would prefer unadjusted information for that market because he or she would know the accounting procedures and would adjust accordingly. On the other hand, for people who are just interested in a broad overview, such as pension funds, it is easier to use somewhat standardized information because it saves time.

National Investor Data Service's NIDSGLOBAL not only provides complete reporting to investment managers about their multi-currency investment portfolios but also forms the basis for the books and records of the investment funds, because it can update regularly the tax data that managers need to use. The multi-currency version of the system runs on Data General's MV machines and DEC's VAX series of computers. At the core of the system is its

ability to store country-specific tax data on a global basis and translate the implications of trades and transactions within one country in the currency of another. Gains and losses based on changes in the value of a currency also are captured and available both for current and future reports. Moreover, the system stores enough contemporary tax data for countries so as to calculate and report the values of various transactions based on the tax laws and requirements of various countries. Financial institutions use the system to value their global portfolios both in the local currency and in the U.S. currency or using any currency requested by their clients as the base currency.

Another issue is double-checking of prices from different sources to ensure accuracy, *but that means finding sources that are truly independent.* Most international financial data winds up coming from a very few ultimate sources. Reuters, for instance, provides prices to Extel, which in turn provides that data to many additional parties. Telekurs AG, a Swiss company with a fairly new North American subsidiary, Telekurs Inc., turns out to be the only other independent source. Salomon Brothers uses both Reuters and Telekurs data feeds to balance each other out. 75% of the time their data agrees on items such as the amount and data of a dividend payment. On the other 25% they were not even close. The sources of these figures are often obscure printed items in foreign languages. Confirmation is virtually impossible. Unfortunately for Telekurs, the nod most often goes to Reuters in those differing cases. This is because Salomon's large institutional clients,who have the resources to independently check prices, traditionally look to Reuters as the ultimate source.

Of late, however, the relationships between data vendors are shifting a great deal, making it necessary for Salomon Brothers to bring in every possible data source to ensure accuracy. The unautomated collection process in foreign markets creates problems for firms such as Salomon Brothers who guarantee portfolio performance against various indices. How that index is calculated and the data that goes into it is very important especially if it is the company's own index. If an institutional client double checks data, Salomon might have to explain why on a certain date, a price from Reuters was deemed inaccurate and a price from another vendor was substituted. Also, what is an official price? For instance, the index of the Frankfurt Stock Exchange is calculated based on prices taken at 12:30 local time, though the market remains open for some time after that. Yet language in some contracts may call for using a closing price, or in other cases an opening one. Country-based security identifiers also differ. One major problem is the lack of reliable information about fixed-income instruments overseas, which is even worse than some securities data since many fixed-income securities trade off exchanges. The inside scuttlebutt is that exchange prices for fixed-income are not regarded as reliable prices. However, the Tokyo Stock Exchange sends out a series of data feeds containing the same database, but each one progressively cleaner. The exchange itself has taken on the responsibility of verifying the data, correcting it, and sending it out corrected.

1.8 The Age of Synergistic Alliances

Many software firms, data feed vendors, hardware companies, and financial institutions themselves are preparing to form alliances that will lead to the better systems for risk management in the future. Under these strategic alliances, parties are free to team up with satellite partners, as long as they orbit the central partner.

One strategic alliance centers on the Unix operating system. Wall Street is looking for heterogeneous multi-vendor solutions, and Unix is perceived to support open architectures that can connect to various Unix-based workstations, especially in the trading arena. However, the Unix alliance has its problems with standardization. Two major groups of vendors have announced different versions of Unix as standard.

Another kind of alliance is by information vendors. For instance, Telerate Systems acquired CMQ Communications, Inc., Canada's leading market data vendor. More recently, Telerate formed a strategic alliance with AT&T to develop an electronic system for foreign exchange transactions. Telerate also formed an agreement with Intex, to jointly market and develop automated market systems for use by exchanges and exchange members. Intex Holdings, Ltd. operates an electronic futures network. Finally, Telerate also joined with Lotus Development Corporation to provide a generic tool kit for traders.

One final kind of alliance is by financial institutions. For example, Merrill Lynch's capital markets area uses the Bloomberg system, a real-time analytic package for fixed-income securities. It also has a 30% equity interest in the company. Merrill Lynch also contribute corporate and government bond prices to the service. With Automatic Data Processing (ADP), Merrill Lynch is developing capital market analytic, and with Data Broadcasting Corporation (DBC) of Vienna, Va., it is offering FM-broadcast data feed.

2. RISK MANAGEMENT AT SALOMON BROTHERS

Salomon Brothers is actively involved in the fixed income securities and derivative products market, where products like government bills, notes, bonds, corporate bonds, options, and swaps are traded. Being a market maker for many financial instruments, Salomon Brothers are expose to the various types of risks that are described in the earlier part of this paper.

In the past two decades, the pace of the financial market has been increased rapidly and customers are demanding better services from the financial institutions. The nature of the business has changed from one of trading in a few financial instruments in large volumes to that of dealing in medium volume but involving a wide range of instruments. Further, new instruments, which could be derivatives of existing instruments, are constantly being introduced into the market. A dynamic and responsive information system is necessary to compete effectively in this increasing sophisticated financial market.

Currently, Salomon Brothers has about 15,000 transactions per day involving over 100 financial instruments. All these products are supported by 12 to 24 information systems.

2.1 Structure of Salomon Brothers' Organization for Risk Management

There is a risk committee of key individuals who have clearly defined responsibilities for managing Salomon's exposures to the various risks arising from all geographical locations and business areas. These individuals are the head of the various business units like credit, retail, capital markets, and its international operations. Within each of these functional areas, there are designated individuals whose responsibilities extends to monitor all existing and new types of risks in the various markets. These are usually the managers or heads of the trading team. Further down the organization, there are specialists who are knowledgeable of different product types. Examples of expertise are: retail customer credit evaluation, corporate bond rating, interest rate, foreign exchange, option pricing, swap pricing, and high yield bond evaluation. They do not have an independent non-trading individual who is responsible for the ultimate global risk management.

2.2 Risk Management Functions and Policies at Salomon Brothers

There is a hierarchy of limits to reflect the strategies, tactics and operational management at Salomon Brothers.

For the *capital markets*, the factors determining the limits set for each business areas are: volatility and liquidity of the market in question, and the responsiveness of the dealers in charge. Because the financial world is dynamic, these factors vary day to day, and even within a day. Ideally, there should be a global risk manager or committee who keeps tap of these volatile factors and constantly vary the limit allocated to each business to reflect the changes. This will allow maximum flexibility in trading without exposing Salomon Brothers to additional risk. In practice, this is too costly to implement as this individual or the risk committee will have to be knowledgeable of all the financial instruments and markets. This could be feasible in the past but almost impossible nowadays because of the fast pace of financial innovations.

Currently, Salomon Brothers rely on the dealers to determine the appropriate trading levels. The assumption is that the traders are in the best position to appreciate the market conditions. Formal approaches such as "price value of a basis point shift" and "present value of the cash flow" of the portfolios are used to establish limits. These limits are reviewed on a daily or weekly basis to ensure conformance. However, any *unused* limit from one trading group cannot be utilized by another group who needs the limit for the day because they are unaware of the unused limits that are available. This is the result of the disparate risk monitoring procedures and stand-a-lone systems that are not linked to each other on an online basis.

In the case when there are turbulence in the capital market such as oil shocks or stock market crashes, all the outstanding positions will be monitored more closely (such as four times a day) by the executives.

I will now describe the procedure for *credit* risk management. The monitoring of credit risk is achieved independently from the traders in the capital market. There is an independent credit group who sets and monitor limits for individuals, corporations and financial institutions. All the exposures to these parties are monitored daily on an aggregated level. As the credit market moves at a slower pace compared to the capital market, the daily monitoring of exposures and monthly review of the credit rating is sufficient.

2.3 Risk Monitoring Systems at Salomon Brothers

The risk monitoring system at Salomon Brothers is a collection of disparate front-end systems (for the traders) and the back office systems that consolidate the aggregated exposures. These systems run independently and are not interconnected. Any needed aggregation of information across these systems is done manually. Salomon Brothers is now considering the possibility of developing a global information technology strategy. Details on the strategy and the current progress can be found in Appendix 1 of this paper.

The implementation of the global information technology strategy is further complicated by the decentralized and autonomous operational environment of Salomon Brothers. They are addressing this problem by defining global corporate data standards for risk management information. In particular, the data base design group of their information technology arm is consolidating the requirements from all departments across the functional areas and geographical regions to arrive at a standard way of storing current and historical information about clients. Further discussion on their progress can be found in Appendix 2.

The second challenge faced by Salomon Brothers is to manage the transition from a variety of systems which have evolved over the years to an integrated risk management system architecture for risk monitoring purposes. They are currently moving towards the ideal and most efficient architecture mentioned earlier in this paper (please see Figure 2). This architecture is to use a common database of transaction level data to drive all front office, back office, and risk monitoring needs. Further, the middle office role is filled by the traders themselves to ensure the integrity and correctness of the transaction information entered into the system.

The transaction level data is grouped by functional areas such as the government desk and finance desk. Therefore there is a need to further aggregate the transaction-level data to provide a view of the total risk exposure of Salomon Brothers in areas where the risk factors of the financial instruments overlap. For example, there is no need to integrate information across the equity and government desk as these markets have very weak linkages between one another. However, the total interest risk exposure of Salomon Brothers can only be obtained by aggregating its positions in government securities, money market instruments, interest rate swaps, fixed income securities, and many other classes of instruments.

2.3.1 The Existing Information Systems at Salomon Brothers

I will now describe the Government and Finance Desks of Salomon Brothers where the pilot projects (which will be described in the later section) are implemented.

The Government Desk. Salomon Brothers is a *market maker* in government securities such as Treasury bills, notes, and bonds. This means that they are obliged to provide the prices that they are willing to buy and sell any of these instruments at any time. The trading desk is based in New York City. There are about one dozen traders in New York, 2 in London, and 2 in Tokyo.

There are not many types of instruments to keep track of, unlike the corporate bond market where there are numerous companies involved. The average transaction volume is about 1,000 per day. It is relatively less profitable than other businesses.

At the end of the day, the outstanding trades in government securities will be funded by lending or borrowing cash through the Finance Desk at the prevailing interest rates provided by that Desk. Suppose we start off with a zero cash balance in our current account. If we feel that government bonds are underpriced, we would purchase some bonds and hold them for say, 1 week, hoping that they will appreciate in value. Since we do not have any money in our current account, we would have to borrow in order to pay for our bond purchase. Therefore, until we sell the bonds eventually to realize our profit, we will be borrowing the same amount on a daily basis. The borrowing interest rate will depend on the market rate and our credit worthiness.

The Finance Desk. The main activities of the Finance Desk is to lend and borrow funds from the money market. The funds are usually collateralized by government securities. The average transaction volume is approximately 1,000 tickets a day. The amount of funds involved is about the same as that in the Government Desk. The bulk of the activities is based in New York City.

2.3.1.1 The Information System Environment at Salomon Brothers

There are three main types of hardware used: the IBM mainframe (3090 series), Prime computers, and Quotron computers.

The bulk of the settlement processing is still done through Cobol programs (totaling approximately 11 million lines of code). The processing is batched together and run on the centralized IBM mainframe. These programs have been written in the 1970's, and they are not documented. Enhancements to these programs are achieved by re-reading the entire program and then putting in a fix. Therefore, this system is not responsive to the constantly changing financial market, which poses a threat to the position of Salomon Brothers in its business.

There is a high level of erroneous data entry due to the separation of deal entry from deal origination. Deal tickets are written up by the traders (often illegibly) and then passed on to data entry clerks, who manually input the deals into the settlement system. Every 1 out of 5 transactions is erroneous and has to be corrected in the next morning. This brings up cost and reduces productivity.

Besides the mainframe, there are 32 Prime computer systems running 5,000 programs (whose origins are uncertain). It appears that these programs are mainly used to model and analyze trends of the market and its instruments. Again, the maintenance of these programs is difficult because of the lack of documentation.

The Quotron systems are mainly used for communication and connection purposes. Through the B page of the Quotron systems, traders could access the Prime computers and analyze the trends of the market prices. The A page of the Quotron system is used for sending electronic mail between the traders.

We now describe other systems used at Salomon Brothers, particularly the trading and accounting systems.

On the trading front, Salomon Brothers uses Composite Information System (CIS) on the Triarch architecture, both from Rich Inc. (a subsidiary of Reuters)[9]. Rich Inc.'s CIS is a video-switching system that offers access to over 110 host computers, time-sharing systems, personal computers, and market information sources through a single keyboard. Triarch, an acronym for Trading Information Architecture, is a distributed processing network for interconnecting video and digital trading systems. Triarch supports several communications protocols concurrently and offers an open-ended architecture. Unix-based workstations clusters connect to the network. Triarch offers the trader intelligent workstations for analytical routines and calculations via dedicated or shared intelligence. Client computers can be attached directly to the Triarch network and accessed via so-called virtual circuits. Virtual circuits establish dedicated channels between workstations and the host computer for optimum communications speed and reliability in the network. This allows traders to run their own analytical routines on the company's mainframes. Software on the Triarch system is written in the C language on a Unix operating system. The choice of C makes the software more portable across different kinds of Unix workstations in Salomon.

Among the newer and upcoming software are the Rich Ticker Generator (a software program to extract logical data records from page-oriented data to create a single logical data

---

9 The Composite Information System (CIS) from Rich should not be confused with the composite information systems research done at MIT by Stuart Madnick and Rich Wang. Any similariy is purely coincidental, and we will make the distinction clear in this paper. Rich Inc.'s CIS emphasizes system connnectivity, whereas the MIT CIS project focuses on logical connectivity.

stream for real-time analytic) and Triarch Network Manager (a utility that runs on a network-attached IBM AT and tracks the Triarch network status and performance and also handles security and permissions–determining which user may access what data). A new touch screen composite page editing utility is currently under beta testing. This product will enable users to create their own composite pages from many different pages.

Salomon Brothers has only in the last couple of years started to pull all its worldwide units into a common budgeting process. A spreadsheet program, TM/1 (for Table Manager 1, from Sinper Corp., North Bergen, N.J.) is used to manipulate the over 370,000 data points. TM/1 was chosen because of its multidimensional capability and deep integration with databases. However, the problem was how to get each budget in computer-usable form from every cost center manager when some do not have computers and most have no computer background. For this problem, Salomon Brothers created compiled versions of a Lotus 1-2-3 template which all managers use as a form to fill in their figures.

2.3.1.2 The View from the Top

Mark Sternfeld is chief information officer at Salomon Brothers. He sees four major differences in information systems for financial institutions over the last five years: workstations, internationalization, volume, and analytic. Interestingly, global risk management ties them all.

"Workstations have just become acceptable at the corporate level [in 1988], with local area networks and connectivity between the mainframe and workstations worked out."[10] Prior to this, the technology was there but only used in an off-line capacity, he contends. "Workstations are now truly a node on the network, a part of the central system. The advantage of the technology now is that we have a network in the mainstream systems' [corporate] effort. It's the way the flow is going. You can't stand in the way of that railroad train: you'll just get crushed."

Internationally, markets have grown so much in scope, says Sternfeld, that "global risk management is a major issue. It was simple in 1983 to consolidate your position, but time zones have made that more difficult. The top executive of the firm used to be around when decisions were being made. Now he's going home when the traders in Tokyo are just getting to work. It has created a more decentralized risk-taking environment. It's difficult to decide when the end of the day is, there is no such thing."

Telecommunications needs have risen from internationalization as well. "[Telecommunications] is no longer broker-to-broker, or exchange-to-investment house," says Sternfeld. "In 1983, it was a squawk box. Now the problem is how to transmit data globally."

Data, Sternfeld contends, represents not only money but the control over the organization. How best to ensure the distribution of that data leads us back to risk elements. "One of the problems to be solved is how to balance between having distributed processing around the globe and central reporting of risk positions," he relates. "We can have a central processor that everyone's connected to, but that defeats the advantages of workstations. Or we could have distributed workstations around the globe. Then the problem is building up reliable enough communications systems to transmit back to a central point for control."

---

10 Maureen Nevin Duffy, "Reaching for Success: Five Years of Automating the Securities Industry," *Wall Street Computer Review*, August 1988, pg. 35. Note that this interview was conducted when Sternfeld was a consultant with Arthur Andersen & Co. His views, of course, should be from a different perspective now that he is at Salomon Brothers.

With vendors' clients locating remote offices in London and Tokyo, suppliers are faced with support problems. The companies, too, are often limited to expatriates because they're familiar with the technology. Sternfeld asks, "How do you build a local support talent for these offices?"

Regarding volume, Sternfeld foresees packaged large central systems, such as TAPS (Trade Analysis and Processing System) which was developed by Morgan Stanley and sold to EDS, in Dallas. The key demand on these systems, he notes, will be their ability to add new products and adjust the central system for changes.

Analytics have been brought to the front end of the "trading decision," the trader's desk, through intelligent terminals. "Expert systems trading where the system looks for arbitrage opportunities and instructs the trade, has really driven the need for the workstation at the traders' desk," Sternfeld comments.

2.3.1.3 Process of Change

Recognizing the ineffectiveness of the existing systems, the management of Salomon Brothers has brought in Mr Mark Sternfeld to spearhead the overhaul of its Information Technology Division and establish its future IT strategy. All this work is targeted to complete by the time they move to the World Trade Center in the second quarter of 1991. The budget for 1983 to 1989 is between 100 to 300 million.

Decentralization. The general strategy is to improve the responsiveness of the IT systems by decentralizing the processing of information on the IBM mainframe. This will done to keep the maintenance of the existing settlement system to a minimum. Meanwhile, a new system that uses the decentralized approach to information processing will start afresh. Specifically, the change will start from the front line of the business (traders) and gradually work towards the back office (settlement), and eventually replace the arcane settlement system.

Decentralization will be achieved by delegating control to the respective user groups (which are organized as trading desks). This will allow the users to decide their own priorities, design, and implementation of the IT systems. All expenses incurred (*eg.* purchase of equipment and hiring of IT personnel) are charged against their individual accounts. As such the users will be able to allocate the resources to the most important business segment in a timely manner. However, it is not clear how the overall IT budget is allocated across the different desks. They have started automating the Government and the Finance Desks.

Traders at the Government Desk can enter the transactions so that their positions are immediately updated. If other traders are trading in the securities, the trader in charge will be informed of the consolidated position within the Government Desk. The latest price of each security quoted by each trader is broadcasted instantaneously to other traders for their information. Sybase is used for maintaining the data.

The presentation of information economize on the limited space available on the screen by overlaying different form of information on the same column, which should otherwise be storing the same form of information. For example, the prices of Treasury Bonds are quoted using 100 as the reference point whereas the prices of Treasury Bills are quoted in the percentage of the actual interest rate. Although users familiar with the standard financial market practices will not be confused, new or moire users would be.

The current implementation of the Finance Desk system allows traders to update the roll-over interest rates that are applicable to each customer. It is designed to look similar to the existing manual forms. Although traders will take a longer time in updating the rates compared to the manual system, they will be compensated in the future by having more tools built for them. We did not get to find out whether this system will provide the traders with their positions. Further, it appears that a lot of knowledge concerning the credit premium of each customer is still stored in the head of the traders. This appear to be the area where the largest number of data entry errors occurs. Therefore, the trader data entry front-end that caters for the updating of new and roll-over interest rates is implemented as top priority.

According to Mr Sternfeld, the applications at the Government Desk and the Finance Desk will merge at the ending phases of the IT overhaul.

Shift of Burden. Another aspect of change is the shift of burden. Data entry will be entrusted to the traders; they are motivated to do so because useful trading information (*eg.* their current positions after they have entered their own trades) will be provided. This not only reduces data entry errors but also enables traders to act upon more accurate information.

Standards and the Fulcrum Project. Meanwhile, to ensure that all the information systems of the autonomous desks would be compatible, the IT Division is developing standards for data and systems. Mr Sternfeld hope that with this, it will prevent them from falling into the same trap as CitiCorp's "uncontrolled decentralization."

Only the core data (which is being used throughout the organization) needs to be standardized. Examples of core data are account numbers, general ledger accounts, and customer names. The process of identifying core data will be ongoing; new data can be incorporated as core data as the business changes and grows. More details on the standardization process can be found in section 2.3.1.3.1.

The Fulcrum Project embodies the standards for systems. It is the model for the distributed information architecture that will be used by Salomon Brothers for all its new systems. The standards are as follows:

- Ethernet (TCP/IP)
- Unix platforms
- Relational data bases:
  - mainframe : DB2 and IMS
  - workstations : Sybase and Oracle
- Sun workstations (80%) and Stellar for high end applications
- X windows standard user interface protocol
- C programming language (Fortran programs will be gradually converted to C)
- Unix related front end tools are being sourced and no potential standard has yet been identified
- Connectivity standards between the mainframe and workstations will be worked in the future.

The Central Technology Group's proposal to use the IBM RT as the standard workstation has been rejected. This is because of Salomon Brothers' aversion to a single vendor relationship. For instance, Salomon Brothers is concerned about getting locked into a proprietary RISC architecture. Pyramid is one of the highest-performing Unix super-minicomputers, but Salomon Brothers is concerned about whether Pyramid will be able to maintain its proprietary edge in three years. A guide book which lays out the standards established by the Central Technology Group will be distributed to all the user groups so that a common ground could be established.

The Data Feed Consortium. In addition to revamping its own IT environment, Salomon Brothers is also leading a consortium that includes 4 other competitors. The consortium will try to persuade information providers like Reuters, Telerate, and Bloomberg to provide digital feeds that allow extracting of information for trading optimization.

Collaboration with Goldman Sachs. Salomon Brother is also beginning to collaborate with Goldman Sachs through the connections of Aurther Anderson consultants. We do not have more details about this project, except that it is in the development of certain information systems. However, we observer that the environment at Salomon Brothers is based on Unix, whereas that in Goldman Sachs is predominantly based on IBM PS/2 (OS/2).

2.3.1.3.1 Standardization of Core Data

The Data Base Support Group is responsible for the design of the standard for the core data.

Ms Erna Adelson is in charged of the data (re-) architecture for the "core data" of Salomon Brothers. The core data includes:

- static information on customers (individuals and firms, and their relationships with other customer - e.g. their subsidiaries).
- information on market instruments.

2.3.1.3.1.1 Objectives

The objective of this exercise is to make the core data architecture data driven rather than application driven and to defined the keys for accessing the data. Further, they will also take this opportunity to address the problems that they face today. In particular, they reassessed the existing data architecture issues and group them into the following categories:

- problems due to functional (business) limits,
- problems due to technological limits,
- problems due to changes in business needs.

2.3.1.3.1.2 Scope

The scope of the re-architecture includes all financial related information, excluding the data of their General Ledger System. It includes information for securities, trading, and investment banking activities.

2.3.1.3.1.3 Potential Problems

Although the final design should serve as the standard for Salomon Brothers, somehow they do not enforce the ongoing new projects to adopt the new architecture. Therefore, this may become a white elephant. For example, the new development projects for the Government and Finance desks are not adhering to the new data architecture.

2.3.1.3.1.4 Issues Addressed

2.3.1.3.1.4.1 Primary Key to All Data

Problem:

Currently, the key to access financial transactions is an 8 character account number consisting of the Salomon Brothers branch/subsidiary code and the customer account number.

However, this key was designed as such because of historical reasons: different transactions used to be executed by different departments and subsidiaries of the company due to organizational structure instead of business or regulatory restrictions. Therefore, with the current emphasis on decentralization, various departments and subsidiaries will be overlapping their operations in the execution of financial transactions (e.g. the sale of US Treasury bonds is no longer executed only in the New York office, but possibly in Salomon Brothers Tokyo, in the London office, etc). Therefore the current key is no longer sufficient to uniquely identify a transaction.

Solution:

Additional information is appended to the existing primary key :

a) Market instrument ID

Information on financial transactions are identified by

i) Product type
The type is identified using a combination of CUSIP code, Euro-clear ID, and Salomon Brothers internally assigned market instrument IDs for instruments without industry standard conventions.

ii) Salomon Brothers department and subsidiary location of execution
For example, a Tokyo Branch customer whose account is with Tokyo may want its transaction to be executed in the London securities office. The system needs the information about the customary transactional location (Tokyo) and the location of this particular transaction (London).

b) Transaction sequence number

2.3.1.3.1.4.2 Parent and Subsidiary Information

Solution:

The current design for the new core data architecture has a field called "legal entity" which stores information of the firm's parent company, its subsidiary, and the respective percentage of ownership. With this information, the system can handle one-to-many relationships among customers. For example, the legal entity record of Shearson Lehman Brothers will indicate that American Express owns 80% of it. Similarly, in the legal entity field of American Express, it would indicate that it owns 80% of Shearson. Each company could have more than one owner and subsidiary.

Problems not addressed:

The current design has not considered the issue of handling changes of company names and changes in relationships due to mergers and acquisitions. For new ventures or mergers, information on these entities will be maintained if they are legal entities. Their relation with their respective parent company will be maintained though the parent and subsidiary fields that allows the linkage and percentage ownership to be stored.

The designers of the core data architecture now work independently of the potential users. These users are expected to be the developers of new and existing applications based on the core data architecture. There does not seem to be any evidence of any obligation or enthusiasm on the users' part to use the ideal data architecture in the development of their new applications.

2.3.1.3.1.5 Opportunities for CIS Research in the Design of the Core Data Architecture

Salomon Brothers seems to be preoccupied with meeting the deadline for revamping its information systems. But the establishment of projects like Fulcrum and the standard data base deign project suggests that they are aware of potential problems of integration. We can join them in discovering ways to preempt problems in logical connectivity.

2.3.1.3.2 Credit Risk Management

Credit risk management at Salomon Brothers consists of the Credit Limit and Credit Review systems. These systems consolidate financial transactions from 20 application systems (with different data base retrieval systems) to provide consolidated information on the company's credit exposures to each customer. The systems do cater to credit exposures for hierarchical relationships like holding companies and subsidiaries by hard coding. Addition of new customers and changes in customer relations are incorporated into the systems manually. Every day there is an exception report that lists credit exposures that are not yet linked to any customer. The credit department would act upon this list by assigning the transactions to the respective organization accordingly.

As each customer has different account numbers in different application (business) systems, a hard coded linkage among these accounts is incorporated in the credit systems. Credit officers could set up these linkages through an online component of the credit systems.

2.3.1.3.2.1 Credit Review System

This system is used to review the credit standing of all customers by gathering information from a few application systems. The information is organized for each customer by holding companies. This organization ensures that credit limits allocated to parent and subsidiary are not violated. The collateral for the credit line is also provided as part of the information.

All customers (subsidiary and parents) could have a few account numbers. There is a numbering system for representing these relationships.

2.3.1.3.2.2 Margin/Exposure System

The system takes information from 25 to 30 other information systems and consolidates all the outstanding transactions with a particular customer.

Problems:

- getting the current prices for some security which are not traded for the day. Historical prices may not be an accurate representation of its current market price. The best estimate for the market price would have to be quoted by the traders which may introduce possible conflict of interest because traders may quote unrealistic prices for their own interest.

- overseas offices operate in different time zones and they have problems time stamping the transaction. For example, as Salmon Brothers New York starts to run its over night batch runs for the day, Its Tokyo office is also in the next working day. As a result, even the latest batch run report would still be out of date. The only solution to this problem is to have an online real time system that provides up to the minute status of the trading position.

2.3.1.3.2.3 Treasury System

This system provides all the credit allocated to all customers and the usage of these credit lines (ie the unused credit limit and the current credit exposure).

2.3.1.3.3 Risk Management at the Arbitrage Desk

2.3.1.3.3.1 Hedging of Risks

Being an arbitrage desk, this department makes money by exploiting market imperfections. It does so by purchasing undervalued financial instruments and selling overvalued instruments, holding on to them for some time and then squaring them out (ie sell what they have purchased earlier and buy what they have sold earlier).

Most of the time, product in question composes a basket of financial products (e.g. it could consist of 4 September T-Bills, 1 30 year bond, and 3 September T-Bond futures contracts). Similarly, the hedging product could be made up of a few market instruments.

Ideally, the arbitrage desk could minimize its transaction costs by first checking elsewhere in the company for outstanding (unhedged) positions that match the desk's positions. However, this prove to be difficult in practice because each position is constantly monitored and traders would have to liquidate them once the scenario is no longer favorable or when it is time to take profit. Traders also have the incentive to organize their own positions instead of looking for offsetting positions elsewhere. They are not rewarded for doing so. Therefore, it is difficult to coordinate the actions of traders especially when they belong to different groups. Besides the difficulty in coordination, it is operationally tedious for traders to hedge their positions. For example, suppose trader 1 has a position A that exactly hedges with position B of trader 2 initially, position B may be reversed before position A and trader 1 would have to re-hedge his position again. To complicate matters further, the market movement may make the risk of positions A and B change over time so that they do not completely cover each other. Then, traders 1 and 2 would have to get together and re-position

themselves. Most traders have more than one position and they tend to work independently. Therefore, it is difficult to incorporate this method of hedging.

Finally, most positions are hedged the moment they are initiated to minimize exposures to market risk. It is too vulnerable for the desk to leave the position opened so that someone else on the trading floor may pick it up for hedging later.

2.3.1.3.3.2 Trading Operations

In their daily operation, the arbitrage traders scan data from different information feeds and resolve inconsistencies based on knowledge in their heads. They could extract data directly from digital feeds and plug these data into their pre-programmed models that are running on their Prime and IBM computers. A new comer or outsider will have trouble making out the meaning of these data as these information feeds assume that the users are "frequent and expert" users. In a way, they have a primitive CIS by hard coding all the semantic information into their spreadsheet or modelling programs. The main requirements for these programs are the number crunching facilities and speed. With CIS, the processing of the "meaning", format, and location of the data could be stored separately from the modelling process. This would make maintenance of the program easier and also reduce duplicate efforts in programming.

2.3.1.3.3.3 Accounting of Trades Done

The arbitrage desk is pegged to the Government desk systems as they can use similar kind of information.

Their unfulfilled needs are:

- profit and loss information, which is currently only available the next day because some information has to be extracted from other batched systems.

- information from their existing applications systems cannot be easily extracted for internal external reporting purposes (especially new requests).

2.4 Risk Management with Composite Information Systems

CIS could facilitate the transition of the information systems environment at Salomon Brothers from its current disparate application systems to a future global information system in the following ways:

- provide mechanisms for aggregating transactional-level data across existing disparate information systems so as a provide a total risk profile of Salomon Brothers on a online basis.

- dynamically consolidate exposure information across the existing application systems so as to allow capital and trading limits to be allocated on a more regular basis as needed operationally. For example, in a normal market, limits could be dynamically shared between various groups on a daily basis to ensure that all allocated limits are utilized across functional and even geographical areas. On the other hand, when there is turbulence in the financial markets, CIS could provide online real time update of up to the minute trading positions. CIS can also allow trades to dynamically adjust

parameters of exposure calculation like volatility of interest and foreign exchange rates, liquidity information, and credit risks.

- facilitate the current risk position aggregation by providing a common interface between the various application systems.

- supplement the current arbitrage and off-balance sheet trading by providing the total risk exposure on a portfolio basis. Currently, these trading positions are not consolidated on a portfolio basis and therefore distort the risk profile. With CIS, these composite trading positions can be grouped as a whole as therefore will reflect the actual exposure of Salomon Brothers for easier monitoring.

- provides tagging of information sources to supplement opinion vending, as mentioned earlier in this paper.

REFERENCES

Adelson, Erna. Private conversation.

Brennan, Peter J. "Portfolio Managers Weather Global Risk Management Challenge," *Wall Street Computer Review*, October 1989.

"How to Tame the High-Tech Monster," *EUROtec*, August 1988.

"Keep Risk at Bay in the Global Banking Era," *Euromoney*, January 1987.

"Managing a risky business," *Banking Technology*, November 1989.

Marion, Larry. "Creating a Global Outlook," *Institutional Investor*, March 1987.

Miglus, Tom. Private conversation.

Maureen Nevin Duffy, "Reaching for Success: Five Years of Automating the Securities Industry," *Wall Street Computer Review*, August 1988.

"Salomon Sitting Next to Japan's Next Four," *Euromoney*, March 1987.

Rosenfeld, Eric. Private conversation.

Sheinbaum, Steve. Private conversation.

Stravis, Robert. Private conversation.

Sternfeld, Mark. Private conversation.

Susskind, Emily. Private conversation.