WALL STREET AUTOMATION: A PRIMER

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by George Schussel and Jack May

During the latter part of 1967, all of 1968, and the early part of 1969, it was hard to pick up any financial journal without reading an article about the problems that stock brokerage firms were having in the back-office processing of securities orders. The front office is responsible for selling securities and thereby generating a brokerage firm's income, but the back office provides the production capabilities to process trades generated by the front office. Insufficient back-office capabilities have caused grave crises for some brokerage firms and for the securities industry as a whole in the last couple of years. As an example, in September of 1969 the Securities and Exchange Commission (SEC) announced that it had fined one of the largest brokerage houses $150,000 for violations of SEC regulations caused by the firm's back office in the preceding year.

The principal cause of the back-office problem is the huge growth in securities trading since 1966. In 1965, the New York Stock Exchange projected that an average trading volume of 10 million shares per day would be reached by 1975; in fact, this figure was reached as early as 1967, while double this volume (20 million share days on the New York Stock Exchange) was not unusual in 1968.

The Exchanges and the individual brokerage firms were not prepared for the fantastic surge in volume; their back offices, which were responsible for processing the sales, were primarily oriented towards manual methods and first- or second-generation computer systems that could not be easily modified to handle large additional volumes. As a result, brokerage firms were far short of the number of trained personnel needed to process all the paper work that was generated; and those firms that did have automated systems found that the computers were swamped.

Because business conditions in the securities industry allow only a very limited time during which the processing for the trade must occur, the additional volume of sales could not simply be backlogged until a capability for handling them appeared. Therefore, this large growth in volume resulted in several problems, many of which were basically related to a large increase in errors. Brokerage house account books became quickly fouled up as securities, trades, and cash were credited and debited to wrong accounts. In the brokerage industry, one error of this sort has a multiplier effect since it can cause several others to follow quickly. For example, when a trade is put into a wrong account, margin interest may be computed incorrectly for both accounts, dividends are credited to the wrong customer, and many other accounting records are similarly in error. In addition to the increase in bookkeeping errors, the high volume strained manpower resources to the limit. This caused the time devoted to internal auditing to be sharply reduced and resulted in an increase in the number of securities misplaced.

The problem which perhaps received the most attention was the fails problem. Once a trade is consummated, a security has to be delivered by the seller to the buyer within five working days. If it is not delivered by this settlement

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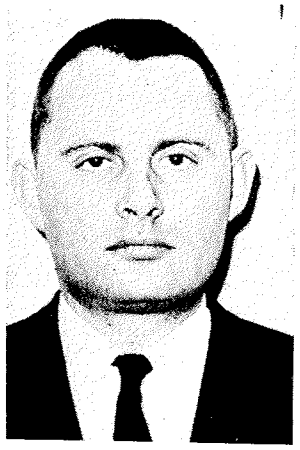
date, it becomes a fail-to-receive for the buying broker and a fail-to-deliver for the selling broker. In short, the resulting effect is that these securities have disappeared from the system. The resulting snowballing effect can be illustrated as follows:

> Broker A sells 100 XYZ at $20 per share to broker B and fails to deliver. Broker B sells those shares to broker C, and broker C to broker D. If none of the deliveries can be made because of broker A's fail, the number of uncompleted transactions result in liabilities of $6,000 caused by the initial $2,000 trade. Arithmetic like this resulted in what has been estimated to be a total value of fails outstanding of about $4.2 billion in December, 1968. If the value of the XYZ stock rose from $20 to $30 per share and broker A still could not find the security, he would, as a result, have to buy the security on the open market for $3,000; but since he would only receive $2,000 in return for delivering it to broker B, he would incur a loss of $1,000. Multiplying the number of fails by this kind of price increase—which was not uncommon during the strong bull market of 1968—and the fails situation and resulting losses became a national problem.

To alleviate these problems, the stock exchanges reduced the hours that they were open during the week in an attempt to cut the trading volume and allow brokerage firms to catch up on their paper work. Brokerage firms hired more personnel, ordered new computer equipment, and the various regulatory bodies (Securities and Exchange Commission, Federal Reserve Board, New York Stock Exchange, National Association of Securities Dealers, etc.) tightened regulations in an attempt to prevent the fails situation from destroying confidence in the securities exchange business. As a result of these interim and costly measures, the cost of business rose sharply and a few houses were taken over or restricted by authorities in the amount of trading that they could do.

As a general rule, the largest security houses weathered the 1968 operations crisis better than the smaller firms because their percentage growth was less and they had far greater financial resources to draw on to alleviate the operations problem. An example of such a firm is Dean Witter & Co., Inc., one of the three largest stock brokerage houses, as measured by sales, in the United States. At the start of 1968, the Dean Witter back-office edp systems were largely second generation, using a Control Data 8050 for communications and four IBM computer systems: a 7074, a 360/30 and two 1401's. All of this equipment was running 24 hours a day, seven days a week. Thus Dean Witter's management, looking towards the future, decided to design a completely new, much more efficient back-office system built around the capabilities inherent in third-generation equipment. It was determined that twin IBM System/360 Model 50's would be adequate to handle the processing workload, so these machines were ordered and Informatics Inc. was retained to help Dean Witter design a comprehensive, completely integrated, and totally automated back-office system. The resulting system, when it becomes completely operational in the Summer of 1970, will be the first (as known to the authors) completely third-generation system to automate the entire back-office procedures of a brokerage house.



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automating a brokerage firm

Computerizing a brokerage back office can be analogized to automating the entire production process of a major firm. The brokerage function is primarily related to the handling of information representing a very large dollar volume. Most brokerage firms of any size have their business generated by a number of geographically disbursed offices. Therefore, the design of a brokerage automation system necessarily encompasses various problems that are encountered in a communications-oriented environment. Fortunately, many of the functions that must be performed by a back-office system are not real-time, because a period of hours or days is allowed from the time data enters the system before certain activities must be performed. Therefore, some of the processing work of the system has to be real-time and on-line in terms of accepting data and transmission, but other functions of the system are much more efficiently, and in some cases, necessarily, processed in a batch-processing environment. The interaction of the real-time and batch-processing modes on the same computer system provides an interesting scheduling problem.

The brokerage back-office system also has the characteristics that many different functions in different programming subsystems may be triggered by one activity or one entry into the system. In addition, most of the system's functions are governed by the various regulations that have been created by government, the exchanges, and the brokerage houses. These regulations change often, so a system has to be constructed in such a manner that it can readily respond to changes.

In laying down the basic foundation for the new operations system, the first and possibly most difficult problem was that it could not operate as a closed loop within the Dean Witter organization. It had to interface with the stock exchanges, clearing houses, and all other brokers, and therefore, the internal system had to be designed to be general enough to interface effectively with outside operations of many different types (for sometimes similar functions).

To give an example of some of the dp problems of the brokerage industry which were encountered, we can cite the following:

1. Dean Witter trades all securities handled by brokerage firms and currently has an active file of over 35,000 such securities. Except for the common symbols of securities listed on the New York and American Stock Exchanges (less than 10% of the above) and a few over-the-counter issues, there is no uniform number identifying a security. All brokerage firms and clearing houses use different numbering systems making communications extremely difficult. In

short, there is no unique way to identify all securities common to the whole industry. (Hopefully this will be alleviated in the future when the CUSIP numbering system designed by the American Bankers Association is adopted throughout the industry.)

2. There is no central depository for securities information, such as dividend and tender announcements, tax exemptions, and transfer agents; all of which are needed for bookkeeping, billing, and handling purposes.

3. Procedures on the floor of the New York Stock Exchange permit specialists (those brokers making an orderly market in certain securities) to execute trades for brokers without returning to the broker certain key information about the order. This information can include the order's internal sequence number which, if it were available would simplify the process of matching the notice of the trade's execution to the order under automated techniques.

Many more such problems could be recounted here, but basically the problem of automating back-office operations in the Wall Street environment is one of subjecting to dp techniques an extremely large, legally complex, and manually involved system that has grown up through the years without any regard to processes for making the system tractable to machine operations, or without any really effective technique of enforcing uniformity on over-all operations.

the brokerage back office

To describe how the back office (or "operations") functions, it is instructional to follow a trade from its inception to its culmination, and to note all of the resulting effects on the various departments of the back office. This description is simplified for the sake of brevity and ease of understanding. In "real life" there are many exceptions to the flow given below.

A trade usually originates with the customer's account executive at a branch office of the brokerage firm. The account executive fills out a form indicating the customer's account number, the side (buy or sell), the security name or symbol, the quantity of shares, the price basis (trade at the market price or a specific price), and miscellaneous information that may be necessary for certain types of trades. Once this is completed, the order is turned over to the back office, which then has complete responsibility for processing, recording, and reporting the transaction.

Most large brokerage houses have communication systems for transmitting orders from branch offices to the appropriate location where the securities are traded. In most cases, this is the floor of the New York or American Stock Exchange; but for over-the-counter securities, most bonds, and securities traded on regional stock exchanges, this may be company installations in New York or other cities.

If the stock is traded on an exchange, the buy or sell order is transmitted to the exchange floor by the brokerage firm. As orders are received by a firm's telephone clerk in his booth beside the trading floor, he signals his firm's floor member on the annunciator boards by pushing a button next to his phone. The member then goes immediately to the booth. Each stock is traded at a particular place on the floor. All buy and sell orders for a particular stock are funneled through floor members of the brokerage firms to this post, where the trade is consummated, and a record of the transaction is published on the ticker tape.

When an order is executed, a wire is sent by the firm's floor representative to the originating branch office, giving the side (buy or sell), security name or symbol, quantity of shares, price per share, executing broker (broker who acted for the firm), and opposing broker (broker from whom the security was bought or sold). Conspicuously missing is the account number of the customer, since the source document for the execution is not necessarily the original order.

internal structure

The order department, which receives copies of all order and execution wires, is responsible for monitoring the system, making sure that all orders are executed properly, and matching and validating the orders to their corresponding executions (there may be more than one execution per order; e.g., an order to buy 300 XYZ at the market price may be executed as 200 XYZ purchased at 10¼ and 100 XYZ bought at 10⅜). These matched orders are then called trades, since they now contain all the necessary information for all accounting and paper work that takes place later.

The purchases and sales (P & S) department (or section of an automated system) is responsible for "figuring the trade"; that is, computing the principal, commission, taxes, fees, and net amount for the particular transaction; recording the trade; and officially notifying the principals of the consummation of the trade. A written confirmation is sent to the customer for each trade, informing him of all the pertinent information about the trade, especially the amounts of money involved. This is equivalent to an invoice for buy trades and a credit memo for sale trades. The trade blotter is prepared, containing a tabulation of all the day's trades for reference. Other blotters, subsets of the trade blotter, are also prepared. They can consist, for example, of all trades in bonds or mutual funds, or trades for a particular branch office or a series of branch offices, and are used for reference by the specific department or office for whom they are prepared.

The P & S department is also responsible for verifying the trade with the opposing broker or the appropriate stock clearing corporation (this is called the street side of the trade). Securities that trade on the New York or American Exchanges, and some over-the-counter securities, are settled through clearing houses. The P & S department informs the clearing houses of all trades in the securities they handle. The clearing house matches the buys with the sells from all brokerage houses and then prepares "balance orders" which inform the brokerage houses as to which other brokerage houses to settle the trade with (these houses may be different from the opposing brokers involved in the original trades; e.g., brokerage house 1 buys 200 XYZ from house 2 and sells 300 XYZ to house 3; maybe it is told by the clearing house to deliver 100 XYZ to brokerage house 4, as a result of all the day's trading in XYZ. Also, the clearing houses note any discrepancies in trades (the brokerage houses may disagree as to price, quantity, etc.). Trades not handled by clearing houses are verified directly to the opposing broker.

Some brokerage firms maintain special records on all trades between trade date and settlement date. On settlement date, payment is made for the trade and the physical securities are delivered. For most trades, settlement date is five working days after the day the trade occurred. During the period between trade and settlement date, it is possible to correct trades that were entered incorrectly before they hit the books. These corrections are usually generated as a result of research based on inquiries from customers regarding their confirmations, brokers regarding their comparisons, and from clearing house reports showing mismatched trades.

The cashier's department, or cage, is responsible for settling the trade on the street side. It receives or delivers

the securities from one owner to another, and is responsible for borrowing or lending securities for short sales and working capital. In short, the cashier's department has physical custody of all securities and handles all securities movements.

The margin department (which is sometimes called the bookkeeping, or credit, or computer records, department) is responsible for recording all transactions by account. The margin department performs the function of customer accounting and therefore is usually the most vital link in a back-office system. All customers have account numbers, as do other brokers (fail accounts, borrow accounts, loan accounts). There are also house accounts, for items like dividends, taxes, profits, commissions, vaults (where securities are kept, called boxes), and so on. The accounts contain the current cash balances and positions in securities.

It is customary for brokerage houses to lend money to customers for buying securities. This is called "buying on margin," and is regulated by government and stock exchange rules. The margin department takes the role of a credit department with regard to margin transactions, and is responsible for determining whether the collateral (the securities themselves) is sufficient for the money lent to the customer. This is not a simple task because the value of securities may vary extensively in an active market and the holdings of a customer may change significantly if he does a great deal of trading. Thus, the margin department must be aware of the current status of every account.

The stock record department is responsible for maintaining an accurate record of all securities in the possession of the brokerage house. For each customer position, there must be a corresponding house position. For example, if a customer buys 100 shares of XYZ, he is debited this position. There is a corresponding credit position of 100 shares in a house account; for example, the box (vault), if that is where the securities are located, or a broker fail account if the broker failed to deliver the securities on settlement date. This record is maintained by security, giving a picture of the holders and locations of all securities at a glance.

The dividend department, which in some firms is part of the cashier's department, processes all cash dividends, stock dividends, stock splits, and bond interest. These payments, in cash or stock, come from the corporations declaring the dividends, and must be allocated to all the holders of the securities. The dividend department must make sure that the number of shares (or bonds) on the corporation's books, as being in the name of the brokerage house, match the number on its own books.

Finally, statements must be sent to all customers. These statements accumulate and list all the activity occurring in the account for a period of one month. They contain all trades, payments, adjustments, deliveries of securities, dividends, interest—everything that affects the cash balance or security position of the account. The statement also contains the closing balance and positions, reflecting the account's status at month's end.

system background

For automating this large data processing problem, Informatics and Dean Witter developed a four-stage plan for implementation.

Phase 1 called for a completely new communications and back-office accounting system, tailor-made for third-generation hardware. The specific goals of phase 1 included:

1. Reduction of the manual workload in the back office as much as possible.
2. Minimization of the number of incorrect transactions entering the system.
3. Prompt detection of the errors that do enter the system; data to be supplied to indicate the source of each error, allowing for quick correction.
4. Reduction of the workload in the cashier's department.
5. A system design anticipating future developments both in the brokerage industry and in computer technology in order to be continually effective and avoid early obsolescense.

Phase 2 called for the use of advanced on-line techniques for communications, order processing, and operation of the cashier's department, plus the addition of a greater number of management reporting functions.

Phase 3 called for an on-line inquiry and processing system for all phases of the back office, including immediate updating of all accounts.

Phase 4 called for the addition to the system of inquiry, management reporting, and processing facilities for the front office, including both research and sales support functions.

The result of the above four phases is a totally integrated and expandable brokerage information system utilizing random-access storage and on-line terminal-oriented processing techniques that will have cost well over $1 million for the software development alone.

The objectives of the four-step approach were to permit:

1. Early development and installation of system capabilities.
2. Minimum disruption and reprogramming as the system evolved through the four phases.
3. Maximum reliability, backup, and cost effectiveness as a result of phased hardware procurement and upgrading.
4. Modularity and expandability.
5. Comprehensiveness.
6. Realizable goals.

In the early stages, the objective was to automate in a fully compatible and integrated fashion the basic batch processing-oriented bookkeeping function. The later phases bring on the real-time systems to support on-line cage functions and order processing.

The final system will allow the execution message of a trade to trigger the trade's complete processing without human intervention. The execution will be matched to the proper order; commission, taxes, and fees will be computed; confirmations will be sent out; and all other tasks associated with purchases and sales will be performed. The customer's account will be updated and the trade stored in the computing system for future processing by fails, bookkeeping, stock record, transfers, dividends and statements—all. automatically.

software and hardware

The problem of choosing a programming language for the coding was relatively straightforward to solve. The computers for the application were manufactured by IBM, and, therefore, a choice limited to FORTRAN, PL/I, COBOL, or basic assembler language seemed to be most reasonable for a large-scale system of this type. Within the system itself, there are two distinctly different types of environments. One very important part of the system involves real-time, on-line processing, including message switching, order transmission, and the processing of any inquiries that need real-

time response. The bulk of the system, however, is more of a standard batch-oriented, data processing problem, involving the construction of transaction files which are passed against master files for updating and report-generation purposes.

The re-entrant nature of the code and the efficiency needed for the on-line part of the system required assembly languages to be used. PL/I could have been used but its efficiency is very low.

The remainder of the system, involving the great bulk of coding and use of large disc files, was a dp effort of great magnitude. To implement it using an assembler language was considered excessive in cost, and would have resulted in more difficult maintenance problems (over 100,000 lines of source code in a problem-oriented language were needed). FORTRAN was eliminated due to its lack of orientation toward file processing and report generation.

Thus, the selection had to be either COBOL or PL/I. PL/I was ruled out because its disadvantages in poor running time and wasteful, ineffective use of core storage outweighed such advantages as flexibility and re-enterable object code. Meanwhile, COBOL had the advantage of being largely self-documenting and of being known by most dp programmers. Thus, COBOL was the language choice for the New Operations System.

Phase 1, the interim capability, was split into two stages. Stage 1 was the installation of a new message-switching system, during the middle of October, 1969. It was decided to utilize the IBM BCCAP (Brokerage Communication) package for the System/360 Model 50, extensively modified by Informatics in order to allow effective multiprogramming and to allow on-line data capture of items that would otherwise require keypunching to enter the system. BCCAP took over all message-switching and order-processing functions that were handled by a Control Data 8050 system. Because of the importance of communications, the Model 50 is backed up by another Model 50 which is used for the back-office processing and accounting portion of the New Operations System.

Stage 2 encompassed the implementation in COBOL of all back-office processing utilizing the two IBM System/360 Model 50's. This part of the system runs under OS/MFT2 and automates the following functions in a batch environment: (1) purchases and sales; (2) fails and stocks borrowed & loaned; (3) margin (bookkeeping); (4) stock record; (5) transfer; (6) dividends; and (7) monthly statements.

system specifications

Fig. 1 is a generalized flow chart of the entire phase 1 system, showing only the mainline programs. There are additional reports and communications programs associated with many of the modules shown in the diagram.

A detailed description of the various programs and the functions that they perform is far too lengthy to be presented here. For example, the system design specification report alone comprised over 1,200 pages. However, out of the very large number of programs and automated functions that are required to support a brokerage house back office, several function areas stand out as being most important.

Communications and order processing. The order processing and communications function is essential to the operation of a brokerage house. The firm cannot function without communicating orders from branch offices to the traders. As mentioned before, BCCAP was chosen as a basis for the communications and order processing for phase 1 of the system. Basic IBM BCCAP performs the following functions:

1. Validates and routes all orders for securities to their proper location for execution.
2. Logs and switches all messages between terminals.
3. Provides hard copy of all messages sent.

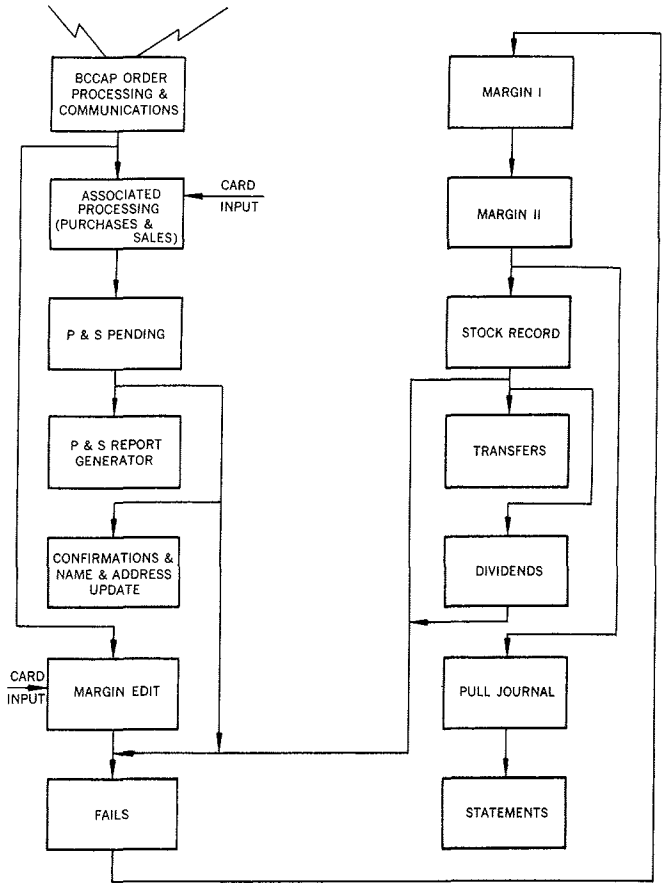


Fig. 1. Program flow.

These functions are necessary but far from sufficient for meeting the standards for a third-generation system. BCCAP was modified extensively to validate, capture, and output in a fixed format the following types of messages:

1. Orders
2. Order executions.
3. Movements of cash in the firm.
4. Movements of securities in the field.
5. Name, address, and other customer control and information changes.

The system requires wire operators in the field to input messages in a fixed format. This data is then entered automatically into the back-office accounting system, eliminating the current need to keypunch all of the same hard-copy data produced by the message switch.

In almost all currently operating brokerage systems, cards are the basic source of all input. In the third-generation system, whereas cards will still be a source of input to data bases, much incoming data is taken directly from communication lines and stored on magnetic tape or disc files. This is a useful capability since all remote data is eventually channeled through the communications system. Obviously, an intermediate hard-copy output and then a re-keypunching of this same data is an inefficient process.

The BCCAP communications system operates during the

daytime hours for the purpose of message switching and automatic data capture, and during this time period, it routes and prints all messages and prepares two output files of the day's formatted message activity to be processed by the New Operations System.

The order matching process is one of the more interesting aspects in the processing of an order. After an order for a listed stock is placed, it is wired to the floor of the New York or American Stock Exchange by the brokerage house communications system, which also sends a copy of the order to the firm's order room. Fig. 2 is an example of such an order

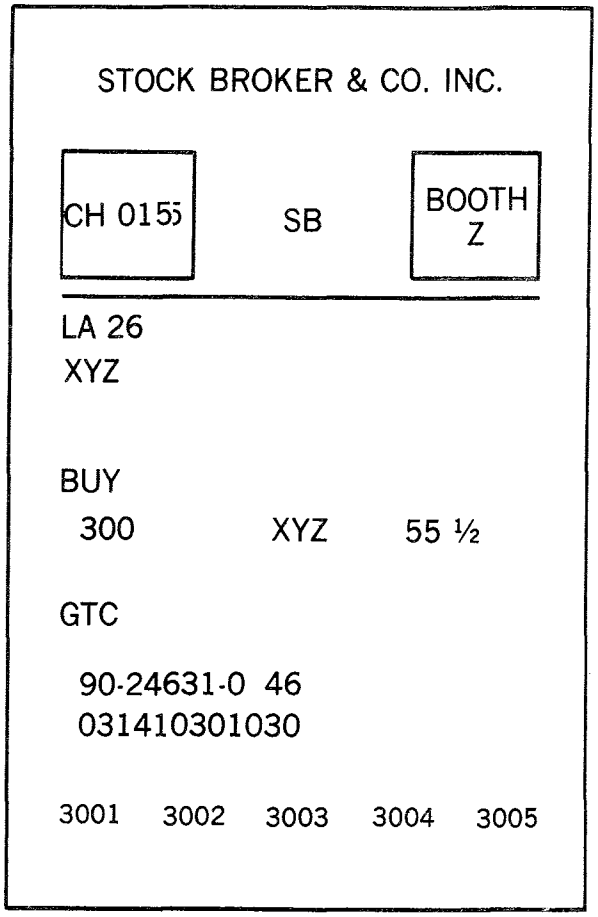


Fig. 2. Stock order.

as it would be printed on a Teletype at any brokerage firm's booth on the floor. The data on an order includes the following items and illustrative examples:

Originating branch office	(LA)
Sequence number of the order	(26)
Buy/sell indication	(BUY)
Quantity	(300)
Security symbol	(XYZ)
Price basis	(55½)
Time in force	(GTC)
Account number	(90-24631-0)
Account executive	(46)

The system goes on to add the date and time of the order. Other control information, including special handling instructions, may be present on the order but are not necessary for this discussion.

The price basis for an order may be MKT for a buy or sell at the market price; a limit price as shown in the above example (which means the customer does not wish to buy until the price falls, or sell until the price rises); or a stop price (STP price), which means the customer wishes to stop a loss by selling if the price goes down to the number given, or by buying if the price goes up to the number given. A combination of stop and limit orders is also allowed. The time in force can be DAY—good for one day; GTC—good until cancelled, or good until a particular date, or for a particular date, or for a particular period of time. If the time in force is left out, the order is assumed to be for one day.

If the order can be executed by the floor broker of the brokerage house, he will execute it and scribble the price, or prices, and the broker, or brokers, from whom he purchased the securities onto the order. He will circle his own (executing broker) number at the bottom of the order slip.

This information is transmitted back to the branch office from the floor of the exchange as an execution message with a copy being dropped off in the order room. Fig. 3 is an example.

The execution message contains the following data:

Branch office	(LA)
Order sequence number	(26)
Bought/sold indication	(BOT)
Quantity	(100)
Security symbol	(XYZ)
Price executed at	(55)
Executing broker	(3001)
Opposing broker	(ML)

The system also adds the date and time.

Notice that the information on the execution message is

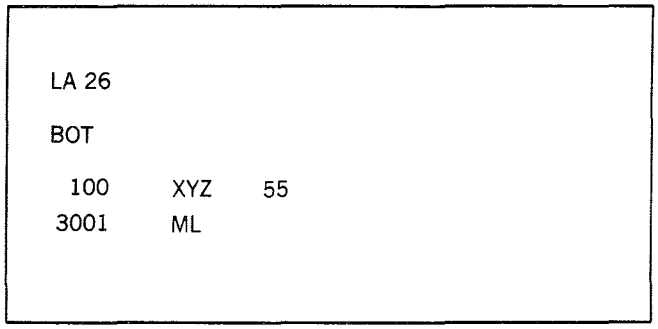


Fig. 3. Order execution message.

not exactly comparable to that on the order. Most significantly, the price, the executing broker, and opposing broker are identified in the execution message, while the account number and account executive are left off the execution message although they appeared on the order.

Under a standard, manual order-matching system, the orders are placed in cubbyholes according to the security symbol. When the execution is received, the cubbyhole is searched for the proper order and the price, quantity, and brokers are written onto the order. It is then sent to keypunching as a trade. This data, plus the data in the security master and name & address master files, is necessary and adequate for all further calculations relating to the trade.

The automated order-matching system, on the other hand, records all orders on random-access devices and contains logic which enables an automated match of cancellations, executions, or partial executions, to the stored order. The matched trades are then sent on, in the automated system, to the figuration run. Of course, extensive validation procedures, as well as inquiry and correction facilities, are required to control orders and executions that might be improperly entered into the system.

If everything ran smoothly, order matching would be a

very simple application problem. The date, branch office, and sequence number of the execution would be used to locate the matching order; quantity, security symbol, and price would be used for validation. However, a problem exists when orders are executed by brokers other than those of the brokerage houses. This occurs when the "home" broker is too busy and gives the order to a "two-dollar broker" or when the trade must be executed by a specialist because the limit or stop price is not close enough to the market price. In these situations, the brokerage house does not always get the original order back; instead, it receives a similar piece of paper on the executing broker's stationery.

Such trades on the New York Stock Exchange do not necessarily contain both the originating branch office and sequence numbers. Therefore, in these cases the execution must be matched on the basis of security symbol, and there is a problem of not being able to guarantee an exact match if two similar orders have been placed. One way to solve this problem is to chain all orders for a particular security together and search for the first order (on the basis of time entered) that meets the proper criteria. From a computer point of view, this may be a time-consuming operation, and results in the possibility of ambiguous situations which require human intervention to straighten out.

The remainder of back-office processing can be split into two general areas:

1. Trade activity (purchases and sales).
2. Record-keeping activity.

The two files prepared by the communications system correlate to these functions. One file (P & S) contains orders, executions, and name and address data, while the other (record keeping) contains cash and stock movements.

purchases and sales

The purchases and sales (P & S) portion of the back-office system is like the billing or invoicing function in an ordinary business. In most brokerage firms, the purchase and sales functions also support the cashier's department, since trading activity generates the movement of cash and stock.

After input handling and validation, the most important function handled by purchases and sales is the order matching. The BCCAP file of orders-and-executes is read in time sequence. When an order is encountered, it is recorded on disc as an unexecuted order. The file of unexecuted orders is continually matched against the incoming stream of executed orders. Once the appropriate order request has been found and matched off against the order execution, the trade is considered to be matched, and this important requirement is satisfied.

This system only performs automatic order matching for trades on the New York or American Stock Exchanges (which constitute most of the brokerage house's business). Order matching is performed several times each day, as the incoming data accumulates, to allow detection of invalid items early enough to provide for correction and re-entry into the system.

During a later phase, the system will be modified to provide expanded security-identification symbols for matching more trades and operation in a real-time, on-line environment. This will result in a far more efficient system because it will permit much earlier detection and therefore easier correction of bad data.

The purchases and sales subsystem also performs trade figuration, the computation of commission, taxes, fees, and any other miscellaneous charges for the trade, using algorithms and tables based on regulations and policies of federal, state, stock exchange, and brokerage house authorities. These values are then passed on for further processing by the system.

The trade figuration is batched and run after the communication transmission cutoff time because of the requirements that some trade calculations are to be dependent upon other trades, either for a single account or for an individual security within a single account.

The pending portion of the P & S system initiates all reporting of trades. On trade date, report records are generated for all trades and sent to the P & S report generator and the P & S confirmation run for printing. The pending run determines the number and types of reports to be produced, based upon the nature of the trade (e.g., a bond blotter record is sent only for bond trades, while a confirmation record is sent for all trades). One of the chief concerns of pending processing is to keep track of security trades (and trade corrections) between trade date and settlement date. During the five-day period between the trade and settlement date, both the customer and broker are given written confirmations of the transaction. If an error in the trade is detected as a result of this procedure, an appropriate adjustment can be made prior to the settlement date of the trade to prevent erroneous information from entering the brokerage house's customer books.

The pending run is also the interface between the purchases and sales and record-keeping functions of the system, and initiates data into all customer and street side accounts. For customer accounts, trade data is sent on both trade and settlement date, the former to give the system an advance picture of the account after the trade settles, and the latter to perform the actual bookkeeping operation. Fig. 4 shows the flow of trades through the P & S system.

The P & S report generator prepares some fifteen reports, including the trade blotter (all of the day's trades), division blotter (trades by divisional offices), exchange blotter (trades by exchange traded on), foreign security blotter, bond blotter, etc. It also maintains the allocation of trade income by salesman and office so that income may be apportioned and commissions paid on a monthly basis.

The confirmation run is another report generator, but it is a separate processing step because of its high priority. Since the confirmation is the customer's invoice, it is important that he receive it as soon as possible in order that the brokerage house receive payment prior to settlement date. In fact, the speed of payment has a significant effect on the day-to-day cash flow position of the brokerage house. The task of updating the name and address file is part of the confirmation run, and assures that the most recent mailing information is available for the customer. The confirmation contains the customer's name and address (from the name and address file), the description of the trade (from order matching), the amounts of money involved in the trade (from figuration), and instructions for payment (name and address control information). Confirmations for customers outside of the eastern United States are teleprocessed to high-speed line printers in Chicago, Los Angeles, and San Francisco immediately after BCCAP is shut down. At these regional locations, the confirmations are burst and placed in window envelopes for mailing, greatly improving the delivery time to customers compared to nationwide mailing from New York.

record keeping

The margin program of the bookkeeping subsystem is considered the heart line or the most important functional program of a brokerage back-office operation.

All the bookkeeping activity of the day is input to this run. This includes stock and cash movements (from communication and cards via margin edit), trades (from pending), "swings"—activity resulting from changes in the names and/or numbers of securities (from stock record), and dividends credited and paid (from dividends). In addition, a file of current closing prices of active securities is entered into the system for the purpose of valuing accounts. Fig. 5 shows the flow of this input through the bookkeeping system.

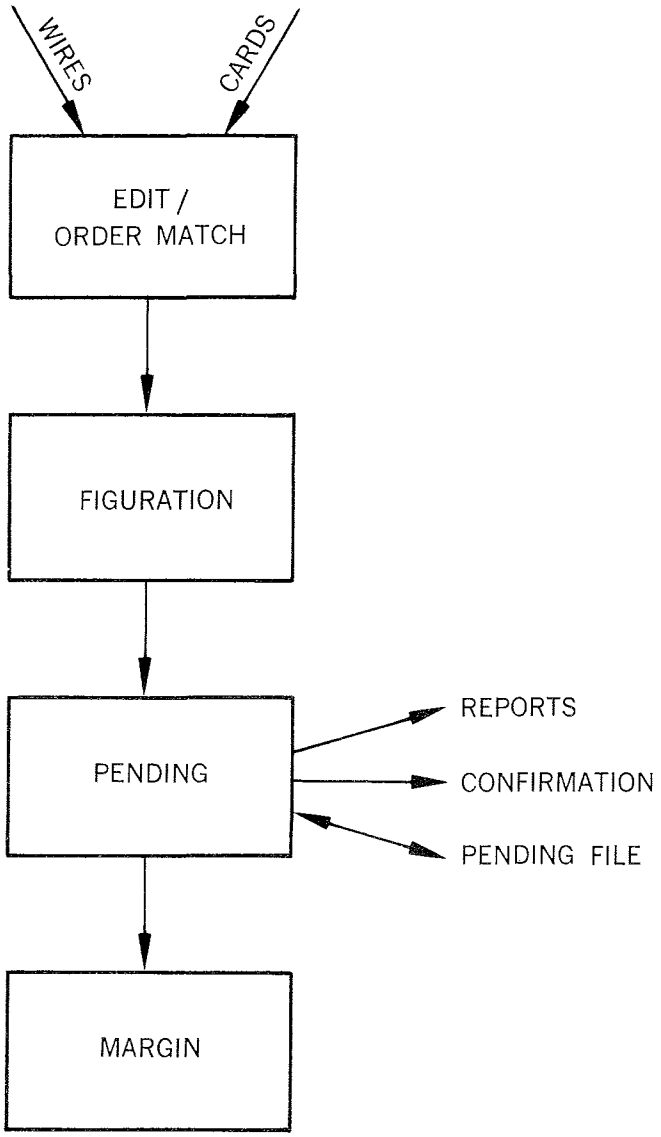


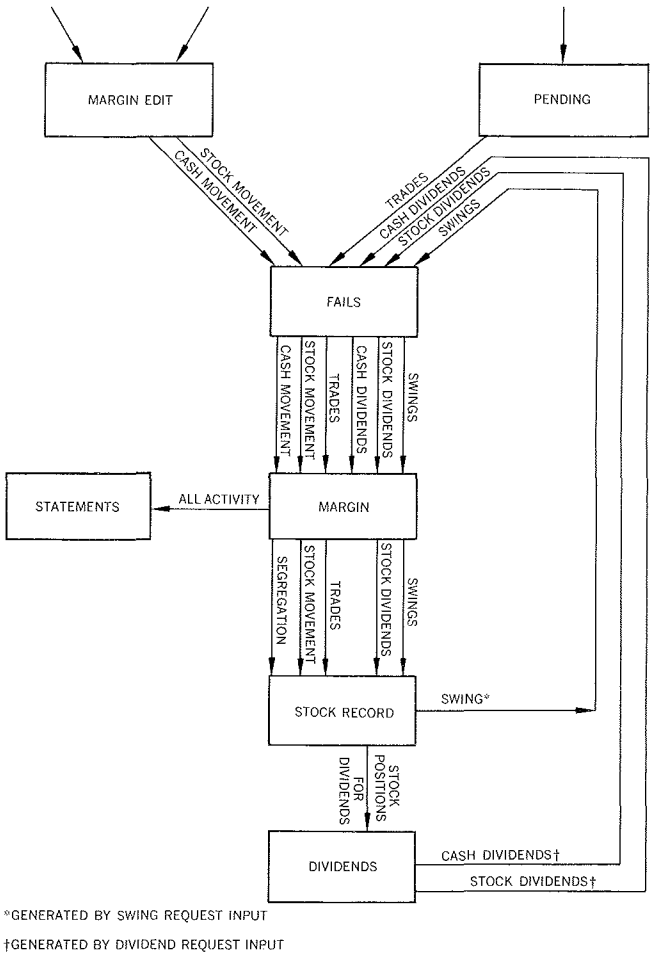
Fig. 4. Trade data flow.

Prior to the start of margin processing, this same input is processed by the fail run, where it controls the two subsidiary files of detail transactions—the fail file and stock borrowed & loaned file.

Because a lack of tight control on fails can easily lead to financial losses, the fails system has to be extremely tightly constructed, with an ability to respond readily and generate management information that is both accurate and current. In the early processing for fails (in the pending run), a determination is made as to whether securities will be handled through a clearing house, or not. This is based on the type of trade and where it was executed. If the item is a clearing house trade, balance cards (punched cards) will be received from the clearing house and will indicate from (to) whom the receipt (delivery) will be made; otherwise, the trade will be settled with the opposing broker, and the fail will be generated automatically by the system.

The processing of fails is separated into three major parts:

1. The first part is the fail-update run, which includes the maintenance of a fail master file, and the preparation of detail fail-activity input for margin processing.



*GENERATED BY SWING REQUEST INPUT

†GENERATED BY DIVIDEND REQUEST INPUT

Fig. 5. Bookkeeping flow.

2. The second part is called fail balancing, which performs the function of balancing the money value of securities received and delivered by the brokerage firm, from and to the clearing houses.

3. The third part, fail reporting, produces all of the fail and stock borrowed & loaned reports needed for research and control purposes, as well as any of the reports required by outside agencies such as the New York Stock Exchange or National Association of Securities Dealers.

The fails processing system centers around a master file which is updated daily. The day's activities in the cage are matched to individual entries on the file (cleanups), and new entries (new fails) from trades that were executed earlier, but are settled now, are also used to update the master file.

The input of activity in the cage for the phase 1 design is off-line. The later phases of the system will change this inventory management from a batch-oriented subsystem to a real-time, on-line system that is more intimately tied to

communications access to various data bases and the use of display terminals.

As soon as the updating of the detail fails and stock borrowed & loaned subsidiary files has been completed, the margin (or bookkeeping) processing phase begins. The day's activity is used to update the two margin master files, the money balance file, and the security holders file—the combination of which constitutes the basic books of a brokerage house. The money balance file contains data relating to money, equity, market value, buying power, etc., of the account, as well as customer control information; while the security holders file contains a record of the positions in securities for each account.

The margin processing system is primarily responsible for updating the customer books of the company and determining whether transactions adhere to rules of the various regulatory agencies, including the Federal Reserve Board, the New York Stock Exchange, and, of course, the policies of the brokerage house itself. Some of these rules can be quite complicated and change relatively often. The system reports all violations or potential violations, and monitors the removal of these anomalies.

The margin processing system is divided into two main phases, margin I and margin II—plus a margin report generator. Margin I accepts the daily transaction files and passes them against the two margin master files to produce an updated money and security position record. Margin II then processes the interim margin master files and produces completely updated master files, report files, and activity output for follow-on portions of the system.

About a dozen reports are generated each day by the margin system. Among the most important are the: (1) daily margin printout; (2) delinquent report; (3) account executive report; and (4) overdue cash report.

The daily margin printout is the largest and most important produced by the system. For each account having activity, this report shows the opening and closing balances, the positions, and the day's activities. In the Dean Witter system, these reports are wired to remote printers in Chicago, Los Angeles, and San Francisco, in addition to being printed locally in New York. This allows Dean Witter's margin departments to have up-to-date status reports on every customer's account.

The delinquent report is transmitted daily to regional offices and contains all violations and exceptional items to be drawn to the attention of the margin department; while the account executive report is a one-line message transmitted over the communications system to account executives at the branch offices, describing balances and buying power for all accounts selected by the account executives. The overdue cash report is wired to all branch offices and indicates those customers who have an outstanding obligation to pay funds to the brokerage house. This data is used by account executives to monitor the status of their customer's accounts.

The progression of margin processing through its final phase causes the following output files to be produced for further processing by other parts of the system:

1. A daily statement detail file (to statement processing).
2. A daily transaction detail file (to stock record processing).
3. A monthly interest file (to purchases & sales reporting).

After margin processing, several other systems process the data and generate reports. The stock record subsystem is responsible for keeping track of all securities for which the firm has responsibility. These securities are owned by Dean Witter's customers or by Dean Witter itself. They are located in vaults (boxes) at various Dean Witter offices, in transfer (from Dean Witter's name or to Dean Witter's name), owed to Dean Witter by other brokers, and so on. The stock record master file contains the locations of the certificates in security sequence to give the total picture of the status of any given security at any particular time. The stock record system prepares transactions deleting old positions and adding new positions as a result of mergers, changes of name, and any other organizational changes of companies that affect customer holdings. These transactions, called security swings, update the bookkeeping files and the stock record master file on the next day.

Stock record also prepares the basic information for dividends processing. When dividends are declared, payments are made to Dean Witter for all securities held in house name; however, most of these securities are really owned by customers, and the payments must be passed on to each customer in proportion to the number of shares of the security in his account. The stock record run has this information in its master file and passes it to dividends processing.

Dividends processing computes dividends, prepares dividend checks and notices for customers, prepares bookkeeping entries for margin processing, withholds taxes on dividends, controls "due bills" from and to other brokers for stock on loan or failed on, maintains an overpayment/underpayment file for dividend payments that do not correlate exactly to its own record, and prepares operational reports for the use of dividend department personnel.

In the logical flow of the system, the final run is statements. Statements are produced periodically, showing the activity and status of all customers. Although such statements may be as infrequent as quarterly, most brokerage firms produce the statements monthly. This run essentially merges all of the detail activity from the margin-processing system with the closing balances and positions, creating statements for all customers. It is the most time-consuming process in the system because of the large amount of printing required. The run also accumulates tax information for reporting to the customer and the government at year-end.

conclusion

This article has described some aspects of back-office brokerage operations, and parts of one major project to automate these functions. Besides being used in back offices, computers are automating many different activities on Wall Street at this time. The Exchanges themselves have developed large computer capabilities and have automated communication nets to expedite the flow of information. Systems have even been designed and proposed for automating the actual trading of securities themselves. And, of course, for some time computers have been very important in stock market research.

The people involved in Wall Street automation problems sense that major changes will be forthcoming in the way that the Street does business. Many of these changes will come about because of the computer capabilities. No matter what changes occur, however, the basic functions described in this article will remain necessary for brokerage firms. As time progresses, the emergence of the computer's capability for managing large information flows will become more and more obvious as the only solution for the major operational problems of the brokerage industry—an industry whose major function can be interpreted as the processing and transferring of information. ■