GLOBAL ELECTRONIC MARKETS
A PRELIMINARY REPORT OF FINDINGS

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Introduction

Understanding more deeply the trend toward markets that are computerized, interlinked, global and trade 24 hours a day was the impetus for this research. To us, practitioners and academics interested in electronic markets, the popular press' depiction of computers controlling the capital flows of the world suggested a more complete understanding of this phenomena was in order. In embarking on this survey we were aware of recent industry studies looking at this area from a number of different perspectives: risk (GAO, 1991), regulation (FIBV, 1993), identification and classification (Domowitz, 1992), emerging markets (IFC, 1994) and review and supervision (SEC, 1994). We reviewed the national debates on the increased role of automation in financial markets during the late 1960's in the US and Canada, examined the emergence of competing structures that flourished in the early age of electronic computers during the 1970's, spread to the UK and Europe in the 1980's and, firmly entrenched in industrialized societies, continued to progress in the 1990's through the rapidly developing free market societies of Eastern Europe and Russia, the Far East and China, and Latin America.

In pursuit of our objectives we were assisted immeasurably by the world's preeminent practitioners of free markets; the organizers, operators and users of the nearly 200 organized securities and derivatives markets and the approximately 80 organizations who operate and/or offer for sale electronic market systems in the world today. Senior executives and their staffs from these institutions gave of their time and talent to answer the 13 page questionnaire. We are grateful for their interest and efforts, without which this study would not have been possible.

We would like to single out two organizations, the FIBV, Paris, France and Gerrit de Marez Oyens, Secretary General; and the Futures Industry Association, Washington DC, USA and John Damgard, Association President and Dennis Murray, President of the Operations Division for their support and for encouraging their members to participate.

This report is a preliminary summary of the data collected to date from the organized securities, options, and futures markets that responded. A subsequent report will be authored on the results of the proprietary electronic market systems operators and market systems vendors survey. Thereafter, a comprehensive analysis of the combined data will be performed and interpretations and conclusions offered. However, the report which follows draws upon the total survey information collected to date, combined with secondary research sources, informational brochures and other literature already in the public domain, some of which are referenced throughout this document.

As the survey data for each particular respondent is to be kept confidential, it should be noted that all specific references to individual organizations is exclusively from public domain documents or previously published material.

The World's Electronic Securities/Options Markets

ATES	Alberta Stock Exchange
AMOS	American Stock Exchange
PERS	American Stock Exchange
ATS	Athens Stock Exchange
CATS	Barcelona Stock Exchange
CATS	Bilbao Stock Exchange
WAS	Arizona Stock Exchange
SEATS	Australian Stock Exchange
BEACON	Boston Stock Exchange
CATS	Brussels Stock Exchange
ATS/2	Bourse de Luxembourg
TRANSVIK	Budapest Stock Exchange
RAES	Chicago Board Options Exchange
GETS	Chilean Electronic Exchange
NSTS	Cincinnati Stock Exchange
SATB	Caracas Stock Exchange
MAX-OTC	Chicago Stock Exchange
ELECTRA	Copenhagen Stock Exchange
GETS	Costa Rica Electronic Exchange
IBIS	German Stock Exchange

The World's Electronic Securities/Options Markets (cont.)

MAE	Guatemala Stock Exchange
HETI	Helsinki Stock Exchange
HKTS	Hong Kong Stock Exchange
SMATS	Korean Stock Exchange
SCORE	Kuala Lumpur Stock Exchange
SAEF	London Stock Exchange
TRADIS	Lisbon Stock Exchange
BIS	Ljublyana Stock Exchange
SATO	Mexican Stock Exchange
GTB	Milan Stock Exchange
MORRE	Montreal Exchange
SELECTNET	National Assoc. of Securities Dealers
SOES	National Assoc. of Securities Dealers
NSE	National Stock Exchange of India
DOT	New York Stock Exchange
OARS	New York Stock Exchange
ABS	New York Stock Exchange
FASTER	New Zealand Stock Exchange
TRANSVIK	Nordic Exchange
STS	Osaka Securities Exchange
SE	Oslo Stock Exchange
P/Coast	Pacific Stock Exchange
POETS	Pacific Stock Exchange
ATES	Panama Stock Exchange
STAMP	Paris Options Market
CAC	Paris Stock Exchange
PACE	Philadelphia Stock Exchange
AUTOM	Philadelphia Stock Exchange
TLPyRE	Santiago Stock Exchange (Chile)
CATS	Sao Paulo
STAQ	Shanghai Stock Exchange (China)
WESTA	Siberian Stock Exchange
CLOB	Singapore Stock Exchange
SAX	Stockholm Automated Exchange
OM	Stockholm Options Market
SSE	Surabaya Stock Exchange (Indonesia)
FATS	Taiwan Stock Exchange
ATES	Tehran Stock Exchange

The World's Electronic Securities/Options Markets (cont.)

KEREM	Tel Aviv Stock Exchange
CORES	Tokyo Stock Exchange
CATS	Toronto Stock Exchange
LOTS	Toronto Stock Exchange
MOST	Toronto Stock Exchange
VCT	Vancouver Stock Exchange
PATS	Vienna Stock Exchange
EQS	Warsaw Stock Exchange

The World's Electronic Futures/Futures Options Markets

ACCESS	New York Mercantile Exchange
APT	London Intl. Financial Futures Exchange
BELFOX	Belgium Futures & Options Exchange
PROJECT A	The Chicago Board of Trade and Bloomberg
DTB	Deutsche Terminborse
GLOBEX	Chicago Mercantile Exchange, DTB, MATIF and Reuters
ATS/2	The Irish Futures & Options Exchange
SMART	MEFF Renta Fija - Spanish Futures & Options Exchange
OMLX	London Securities & Derivatives Exchange
MIF	Mercato Italiano Futures Exchange
ATS/2000	New Zealand Futures & Options Exchange
SFTS	Osaka Securities Exchange
OTS	Osaka Securities Exchange
ATS/2	Osaka Sugar Exchange
OTOB	Austrian Futures & Options Exchange
NEAT	RAS Commodity Exchange (Singapore)
SOFFEX	Swiss Options & Financial Futures Exchange
SYCOM	Sydney Futures Exchange
ATS/2	Tokyo Commodity Exchange
FACTS	Tokyo International Financial Futures Exchange
TSE-O	Tokyo Stock Exchange - Options
TSE-F	Tokyo Stock Exchange - Futures

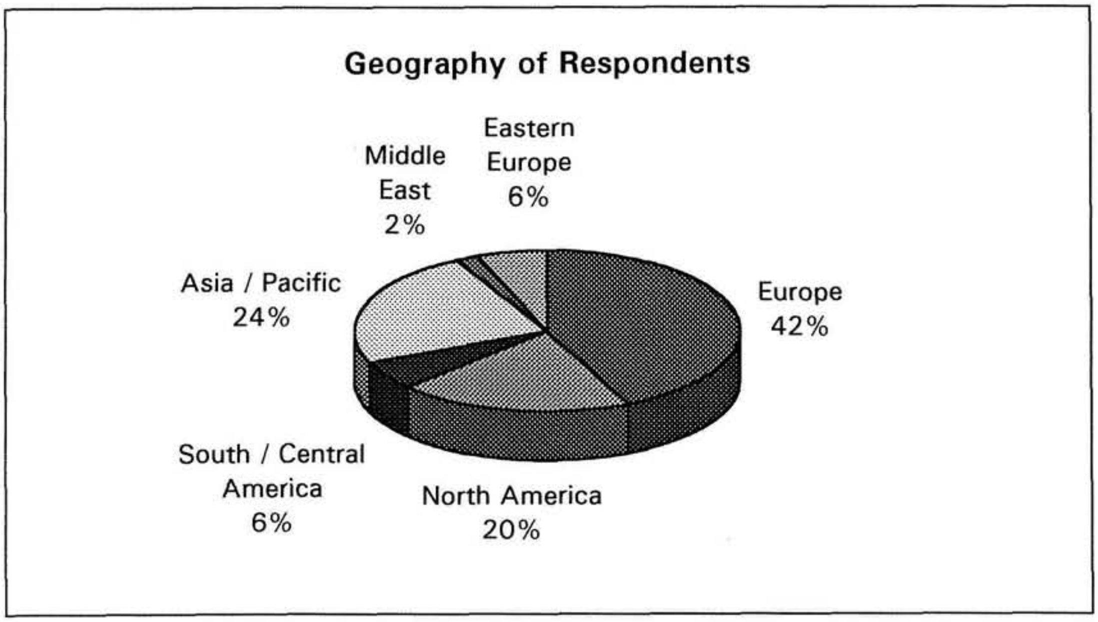
Respondent Profile

Number of Respondents

The Survey was sent to 193 exchanges, and 80 proprietary systems operators and/or vendors. This report focuses on the data collected from the 52 exchanges that responded with a filled out questionnaire from the total of 89 exchanges that responded, the remainder of which: 12 responded that they had partial electronic systems; 7 responded that they are in the planning stage of such systems; 10 responded they do not have and are not planning such a system; 6 which responded that they have an electronic trading system but are still in the process of filling out the questionnaire; 2 arrived too late to be included in the results reported here.

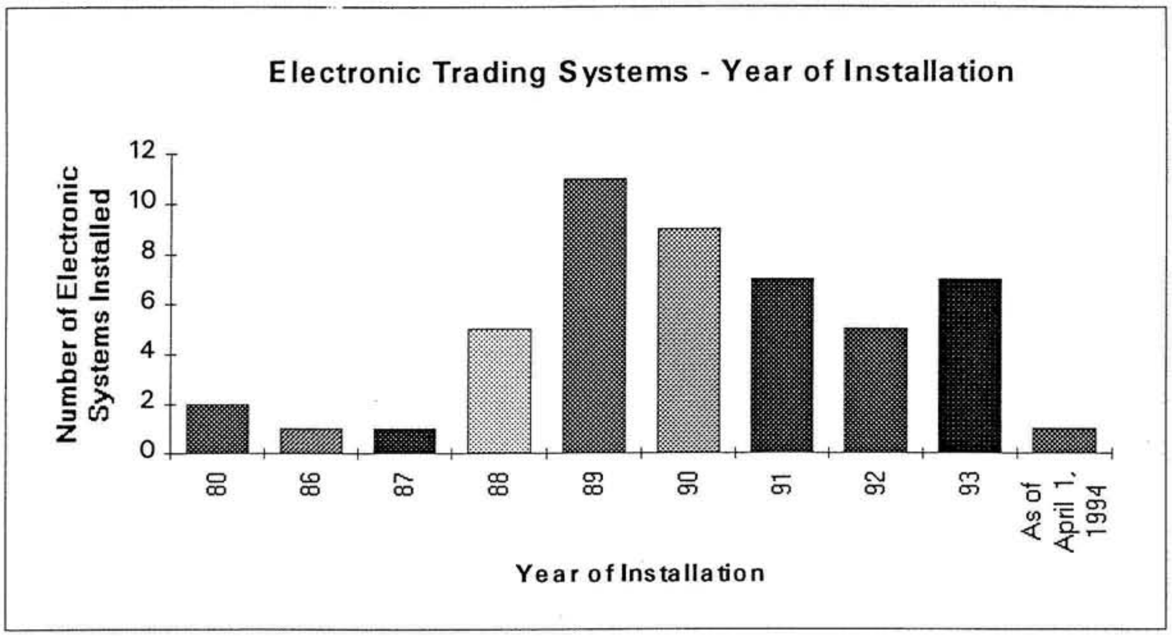
Geography of Respondents

The respondents represented a cross section of the world's markets:



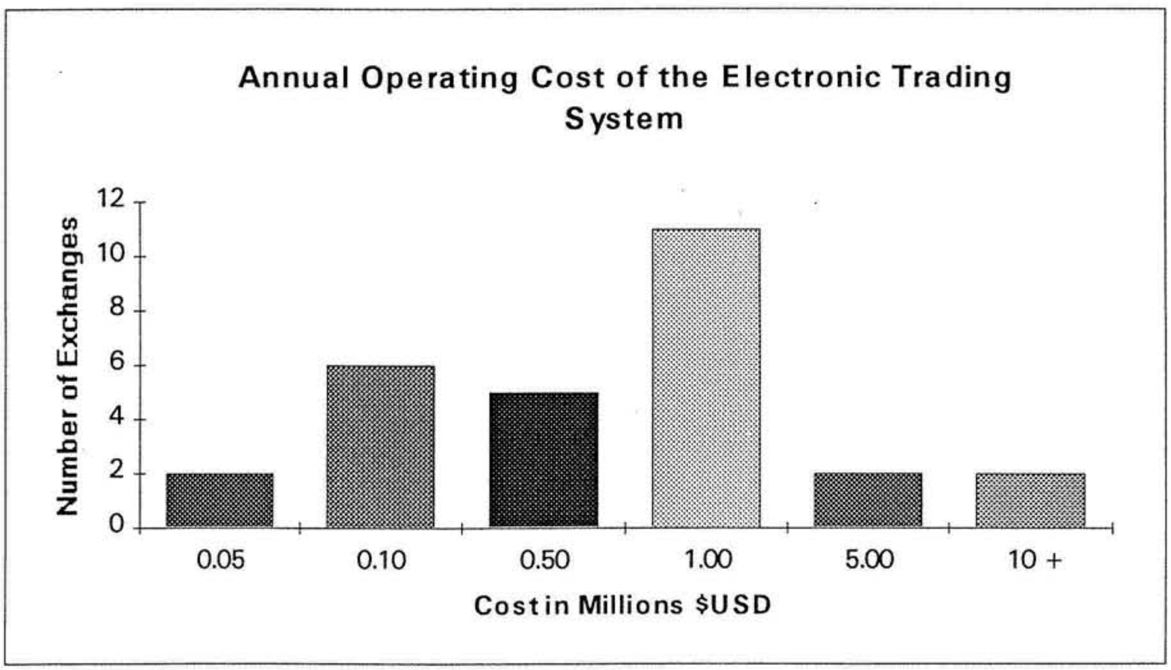
Year of Installation

The year in which each electronic market was installed is indicated in the accompanying chart. In 1989 the most systems were installed (11). So far in the 1990's the average is 7 per year, a significant increase from the 1980's when it averaged 2 per year.

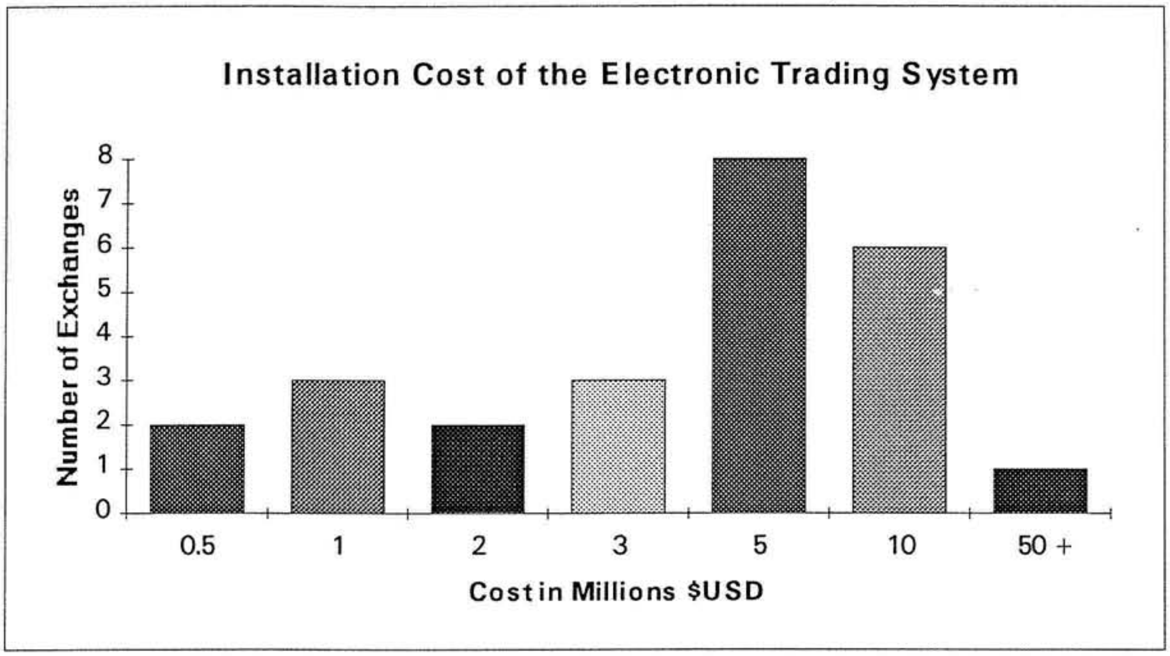


Cost of Technology

Of the respondents who described their costs, the average annual cost of operating their system was US $ 2.3 million, with the median cost at US $ 1.1.



The average cost of developing the system was US $ 12.8 million, with the median cost at US $ 5.3.



Hours of Operation

The average respondent reported it operated an electronic market 8 hours a day, 5 days a week. The actual hours in the day varied between those exchanges that operate after hour markets over varying amounts of time (18% of respondents), those that operate side by side electronic and traditional markets (42%), and those that operate electronic markets exclusively, some operating during their normal business hours and others operating in varying times up to 24 hours a day (2).

Products Traded

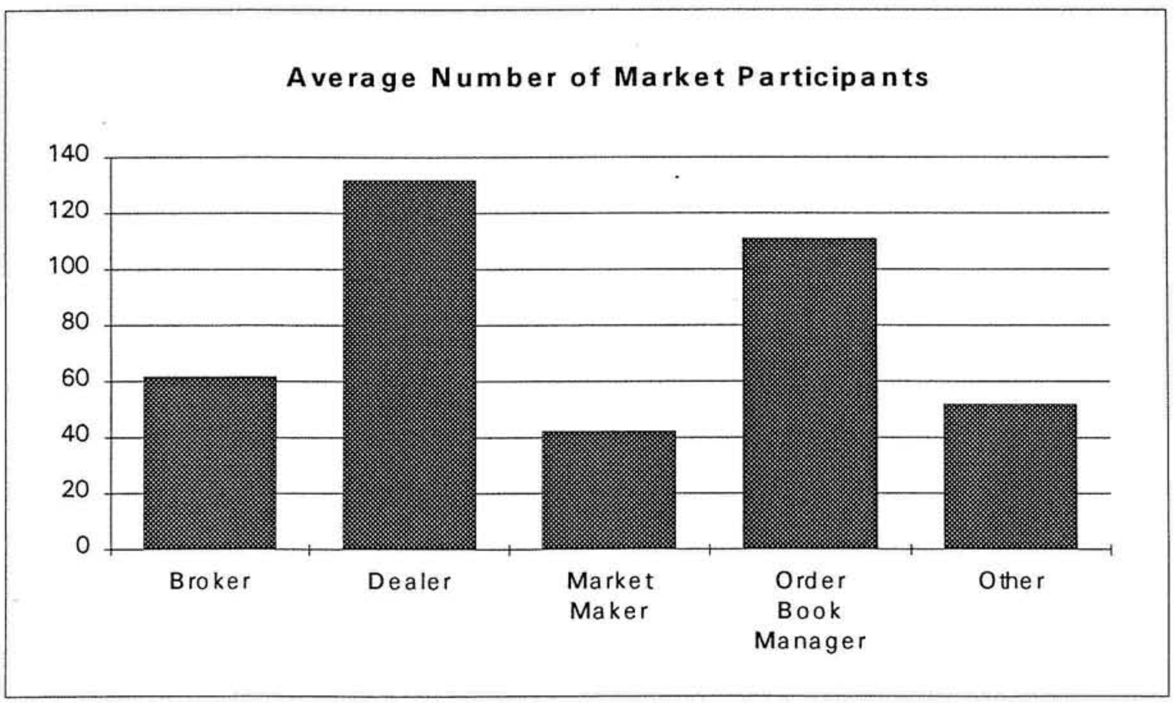
The respondents reported that they traded the following products on their electronic systems:

Products Traded in Electronic Markets

- Stocks
- Corporate Bonds
- Government Bonds
- Options on Equities
- Options on Indexes
- Futures
- Warrants
- Swaps

Market Participants

Each electronic market is structured to allow various market participants a defined role. Sometimes these are exclusive roles as in the assignment of the specialist at the New York Stock Exchange, or the Hokeman's role at the Amsterdam Stock Exchange. Other times these assignments are in competing roles, as in dealing for one's own account or as agents for customers. The average number of market participants and role of each is described below for the average respondent's electronic system.



Evolution of Technology in Financial Markets

The application of technology to financial markets began in the early nineteenth century when the telegraph and the Morse code ticker became the mainstay of electronic price dissemination. However, it is not until the beginning of the twentieth century that technology appeared in more familiar forms with the development of telephonic communications and, in the 1960's, the introduction of automation to support information display.

It was during this time that entrepreneurs and exchanges alike began to experiment with the rapidly integrating technologies of computers and communications to both make markets as well as to integrate markets. The early experiments of this era led to the development of the INSTINET and AUTEX off exchange trading systems in the US, the COMEX. (later to be renamed SCOREX) small order execution system of the Pacific Stock Exchange; ARIEL, a short lived off-exchange trading system in the UK; the ABS bond trading system of the NYSE; the CATS electronic trading system of the Toronto Stock Exchange; and the INTEX, Bermuda and New Zealand Futures Exchanges' extension of markets technology to futures markets. Also in this period the development of information linkages between exchanges was undertaken. Previously prices on similar securities varied across exchanges as prices reflected only locally available information and liquidity. The US's Intermarket Trading System introduced in 1978 as part of the National Market System, the IBIS system in Germany (1991) and the SENN Network in Brazil (1983) are examples of how technology was used to link the markets to ensure the maximum available liquidity for orders.

Increasing volumes were another major factor that brought technology to financial markets. For example, in the late 1960's, US exchanges were forced to close one day a week to process the backlog of trades from the previous days, and over-the-counter markets were clogged with volume. Technology also became essential to support a growing global financial community, and allow for larger trading volumes while guaranteeing market integrity and efficiency. In today's highly integrated and competitive markets, technology has become a strategic and competitive tool to attract and retain order flow.

MOTIVATIONS for INTRODUCING ELECTRONIC MARKETS

Positioning for Future Increasing Trading Capacity	Very Significant
Extending Geographic Reach Creating New Markets Introducing New Products Off-Exchange Trading Pressures Competition	Moderately Significant
Regulation	Relatively non Significant

While technology has facilitated innovation and trading efficiency in the securities industry, it has now become such a critical part of financial markets that it is starting to shape these markets. This was illustrated by the London Stock Exchange's Big Bang in 1986: the introduction of the screen-based dealing system SEAQ unexpectedly led to the rapid abandonment of floor trading. It was thought that improved access to a broader range of information allowed by the new computer system along with new rules and regulations provided a superior trading environment in upstairs dealing rooms. Floor trading in the UK became an aside to screen-based trading, and eventually disappeared.

Another illustration of technology shaping financial markets, to a completely opposite end, is the increased use of technology on floor markets to support the human interaction of an open outcry or auction market. The automation of the specialist books at the NYSE, AMEX, Luxembourg and Amsterdam exchanges; the hand held devices that are being deployed in the futures markets in Chicago and New York; and the voice recording devices used on the Sydney Futures Exchange are all reinforcing the strategic use of technology for enhancing and sustaining floor markets.

Because technology is a necessary component of a financial market, it can both constrain and expand the market environment to its own limitations or new capabilities.

CONCERNS in LIMITATIONS of ELECTRONIC MARKETS

Flexibility Performance Constraints of Communications Limitations on Number of Terminals Limited Capacity to Add New Products Limitations on Inquiries Transaction Volume Reliability	Moderately Significant

One prime example of change that new technology has caused is in the face to face and/or telephone communication that prevailed on markets for many years that is now being replaced in some markets (Paris, London, Toronto, the US's NASDAQ market), by electronic communication. Some believe that this new medium is less rich and does not convey the behavioral cues information traders deem valuable to discover trading strategies and/or positions of other market participants. At the same time the possibilities of viewing many more information sources than just the behavioral cues of fellow traders, in ever increasing interlinked markets, gives impetus to the analogy of trader as cockpit navigator tied to the outside world by electronic inputs and analytics.

Notwithstanding the above, technology may eventually make some market structures obsolete. In some applications, by allowing higher trading volumes and more complex financial instruments, technology could ultimately dictate partial or total elimination of human traders, to be replaced with electronic systems (Hakansson, et al. 1985). For example index basket traders are more interested in executing all their trades at a precise moment, rather than suffer from market distortions as each stock in the basket brings more recognition of their pattern of trading. Such trading has been a favorite of new electronic crossing networks, such as Posit and the Crossing Network in the US.

Components of an Electronic Trading System

We have seen how technology has evolved to augment existing markets and enable new ones. The sponsors and users of these markets view electronic systems as black boxes of technology. Electronic systems themselves are understandable as markets, (that is they serve market participants and perform specific functions to support the trading and investment interests of the financial intermediaries and their clients), but their users generally do not understand how they actually accomplish these tasks.

DEVELOPMENT ISSUES of ELECTRONIC MARKETS

Gaining the Interest of the Sponsoring Financial Community Deciding on In-house Development versus a Vendor Package Finding Development Personnel Delays in Development Project Funding the Project	Moderately Significant

While technology is becoming more user-friendly and flexible, it is important to recognize that a lot of structure is embedded in an electronic system. Therefore, when applying technology to markets, critical issues regarding the system architecture and functional design have to be addressed.

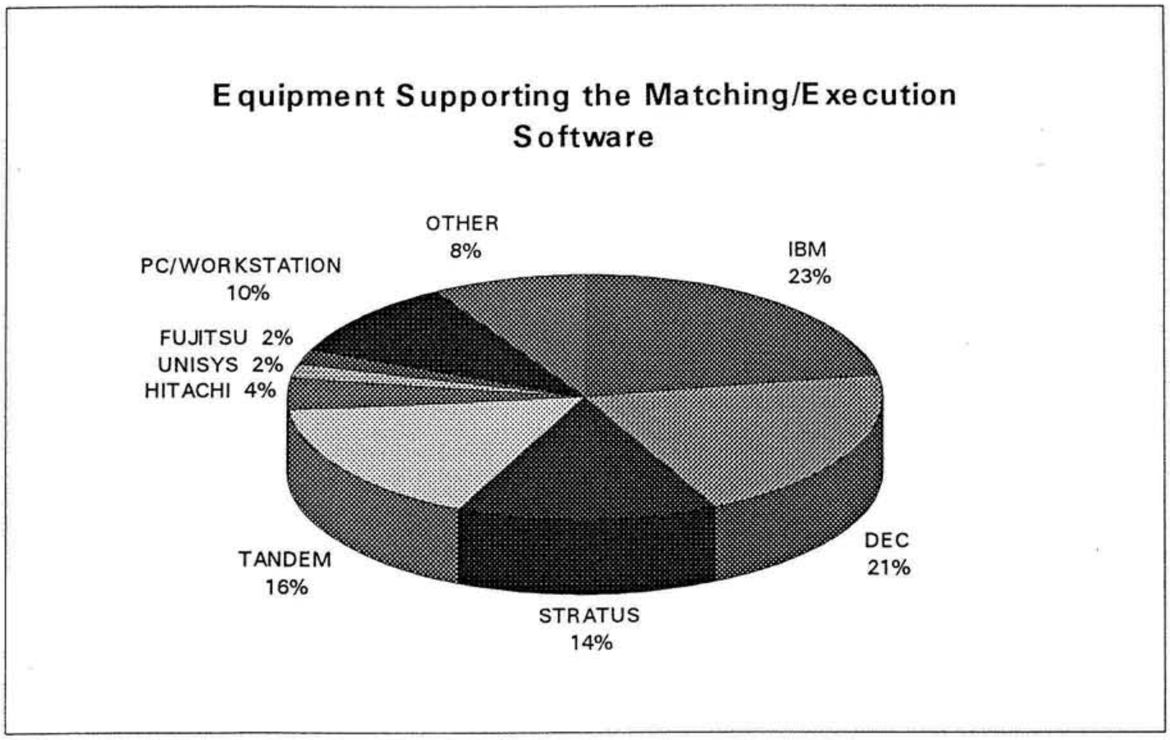
ISSUES in INTRODUCING ELECTRONIC MARKETS

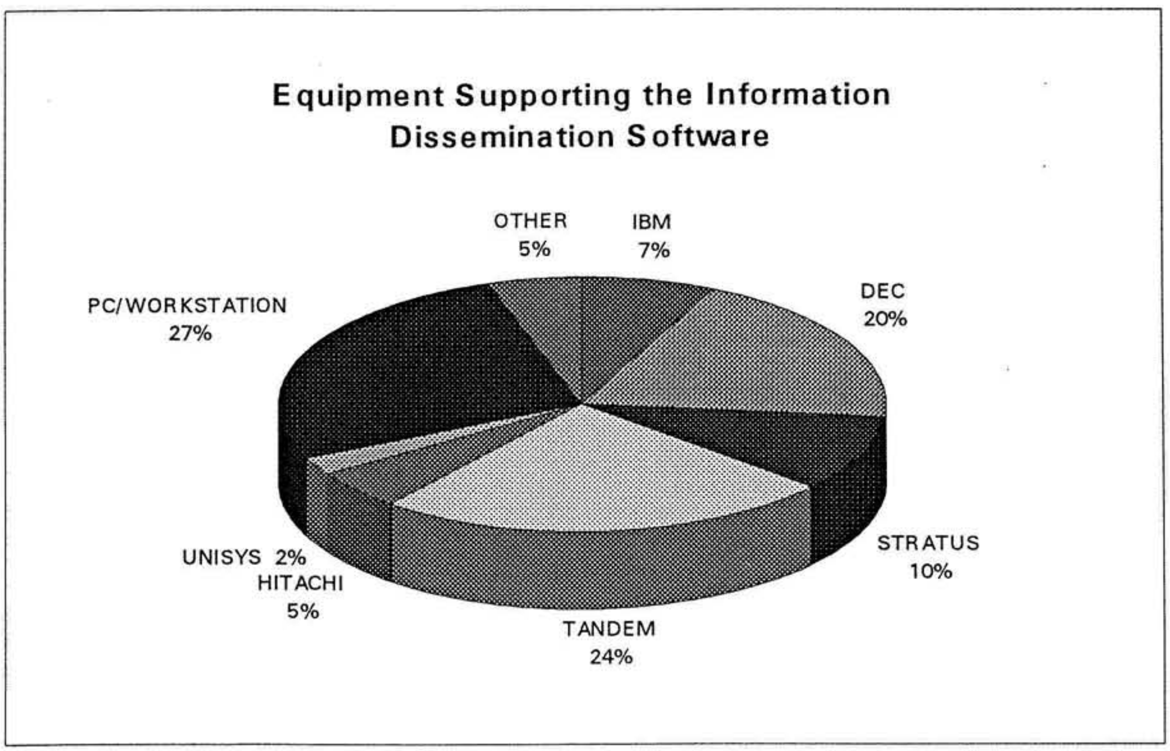
Resistance of Financial Community Training Liquidity	Moderately Significant
Communication Availability Sustaining User Interest Regulation	Relatively non Significant

An electronic trading system typically contains four major components; hardware, software, the terminal and the communications network.

Hardware

The hardware includes both the machine on which the software is running, and the terminals through which information is entered and accessed. Increasingly the terminals are being replaced by local computers. They share the functionality of the entire system with components operating at the user site and other components operating at a host, and in the case of the communications network, at the hub site. this area with almost every vendor represented in the current list of electronic market systems.





Each of the major functions of an electronic trading system, order placement, order monitoring, order matching, trade execution, trade reporting, administrative query and messaging, and market information (price, volume, quotes, etc.) dissemination can be dedicated to a specific machine, a series of machines or centralized on one host. Their is no shortage of choices in

Software

The principal application components of the system are the user's presentation and entry application, the order matching or trade execution software, and the server application that provides messages to and from the host and updates the host databases. User access is increasingly available through PC or workstation graphical user interfaces, which operate as client applications.

These applications are typically supported by memory resident or database management software which stores both dynamic information (orders, cancellations, queries, trade executions, etc.) and static information (glossary of securities or contracts, historical market information, authorized users, destination codes, etc.). Information is stored at both the client and server sites.

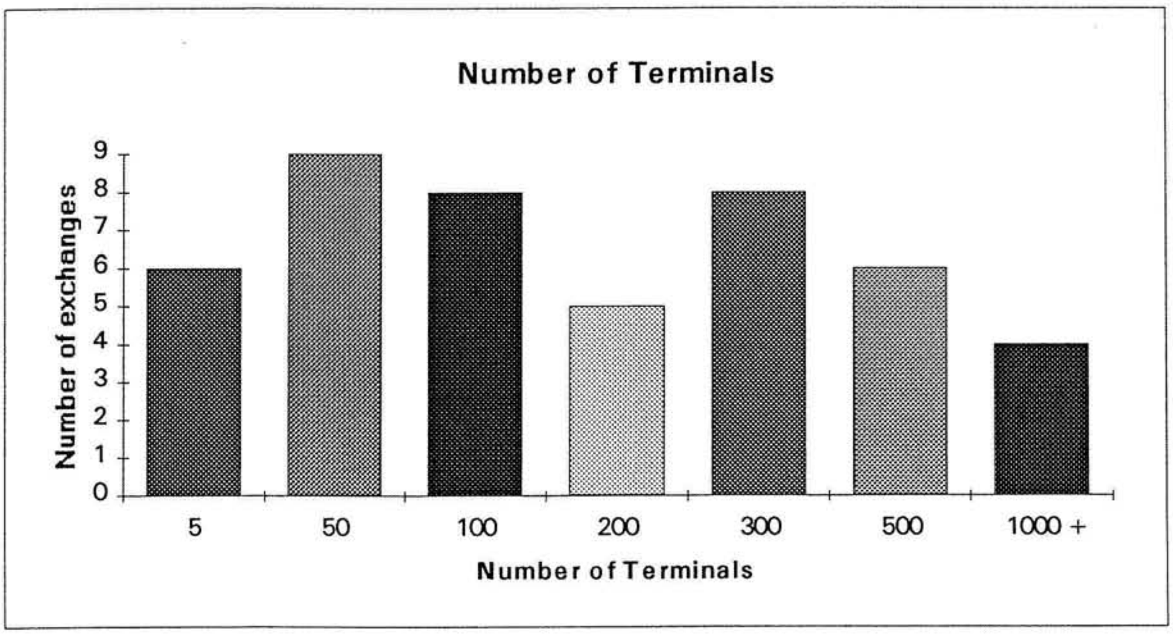
Exchanges, Computer and Software Companies Commercially Offering Electronic Market Systems

- Arthur Anderson (with DTB & SOFFEX)
- Chicago Stock Exchange
- Global Trade, Inc.
- Hewlett Packard (with Singapore Stock Exchange)
- Intertec Management Systems (with EDS)
- OM Systems International
- Tandem Computers (with NYSE)
- TCAM Systems (with Vancouver Stock Exchange)
- Femcom Systems
- Reuters Holdings Ltd (with Globex)
- Sungard Capital Markets Inc.
- Task Management, Inc.
- Transvik Ltd.
- EFA Software Services

The network management software handles the broadcast of market data to market participants and outside vendors, and the interactive message handling and routing associated with the order placement and trade execution components of the system.

Terminals

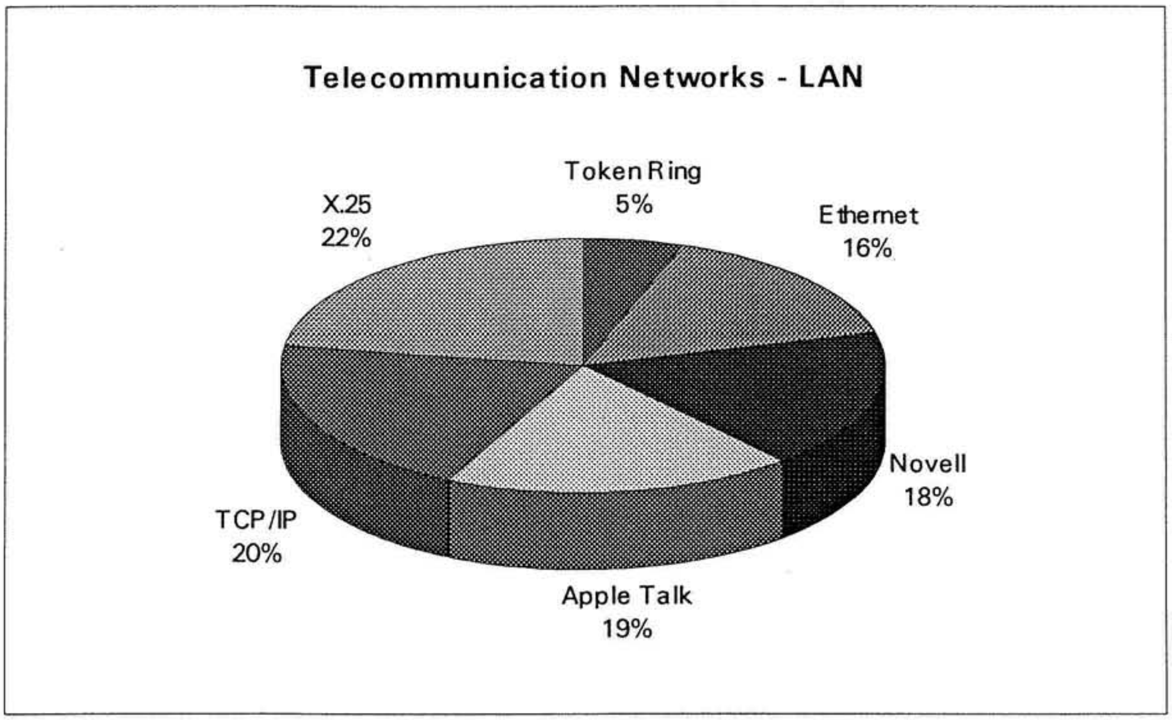
Increasingly, dumb terminals are being replaced by PC's or workstations with these devices being viewed by end users of electronic markets as the manifestation of the functionality of these markets. More information is being displayed using compartmentalizing ("windowing") techniques for scrolling news, market minding, moving tickers, working orders, executed trades and order book displays. Increasingly, electronic market operators are recognizing the limitations of the PC and workstation as the device of choice, opting in addition for an electronic linkage of the markets central execution computers directly to a participating members own computers. This has increasingly been the way in which the US markets have operated and the way in which other markets are heading, (i.e. the Paris Stock Exchange and Globex are two recent examples of this type of approach). The number of terminals presently in use on electronic markets are depicted below.



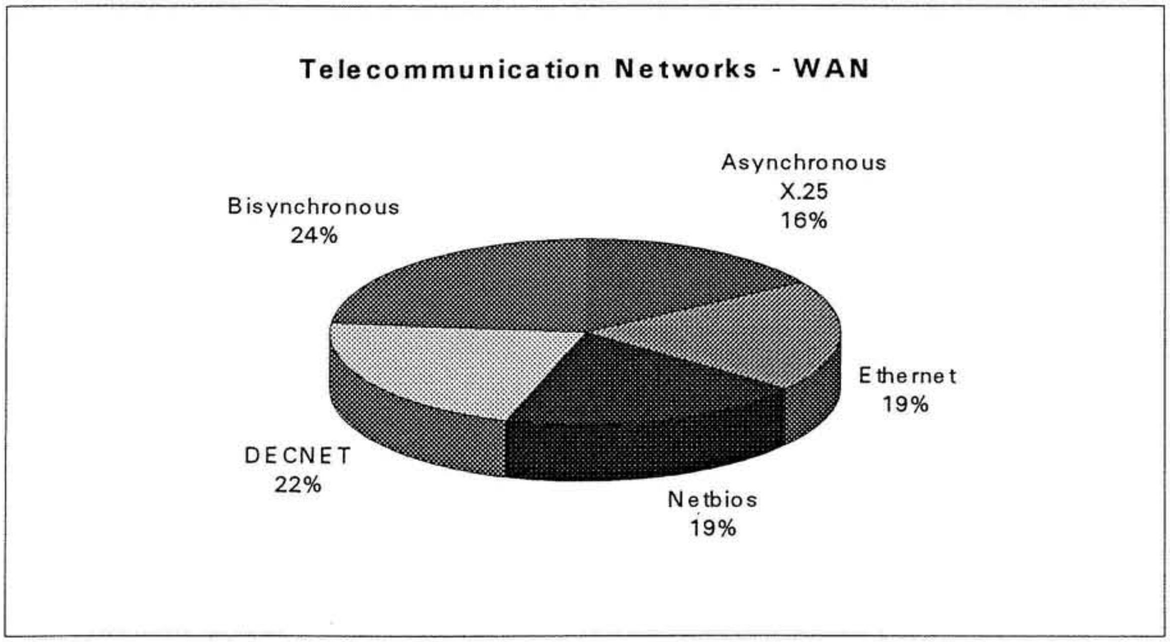
Network

The network itself links the different system components together. Like hardware and software, different categories of networks fulfill specific tasks. Separate networks are commonly deployed for the broadcast of market information to the secondary vendors (ADP, Dow Jones, Quick, Telekurs, etc.) as well as the primary market participants. In other cases both networks are combined. The Sydney Exchange, for example, uses VSAT (Very Small Aperture Terminal) interactive technology for market information dissemination and trading interaction.

Looking at the topology of the network, the local area network (LAN) links components and market participants who are geographically close to the system and the wide area network (WAN) links geographically dispersed components and participants. Typically, LAN's are constructed around Token Ring or Ethernet technology, the WAN's around X.25, TCP/IP or, more recently ATM (Asynchronous Transfer Mode) and ISDN technology. In some cases the LAN network is the only means of access as the market is confined to a localized community of participants as in the case of the Luxembourg Exchange.

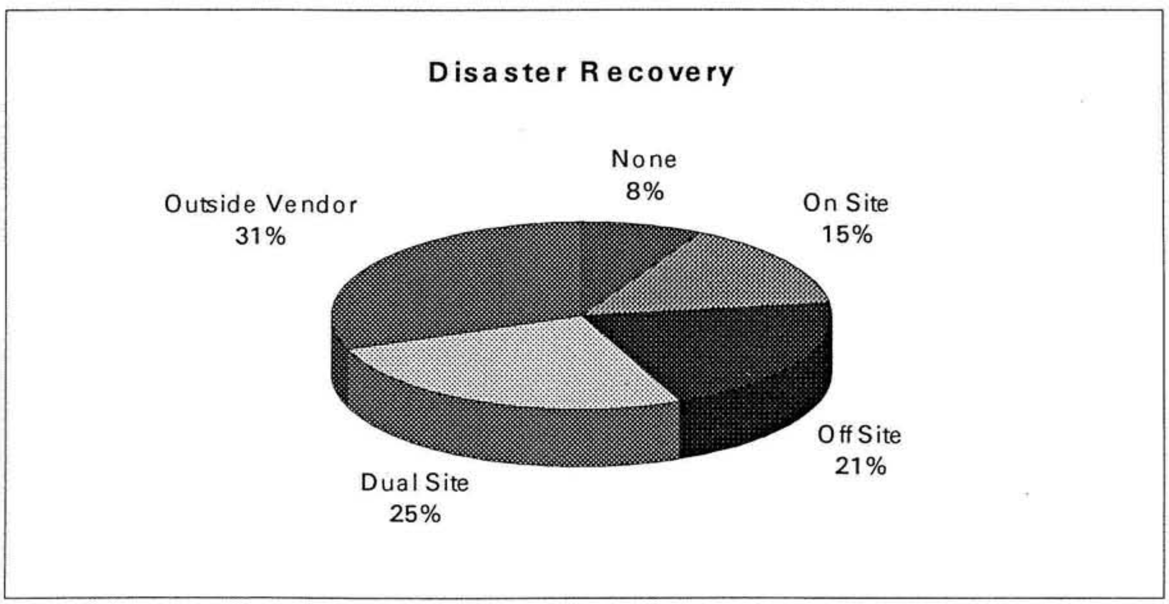


The WAN can span geographical boundaries, as in the case of Globex in the futures and options market or Instinet in the equity markets. More commonly, it is confined to a particular territory or country as is the case in Japan and Thailand. Increasingly, exchanges are aligning with network providers to share costs and leverage in place communications facilities as with the NYMEX's Access system and AT&T., Globex and Reuters, and the Chicago Board of Trades Project A and Bloomberg.



Disaster Recovery

A final, and increasingly critical component of the system is the means of recovering from a systems failure. While a terminal or line can be replaced rather quickly through spares or alternate lines, there are unique components of the system that have no commercially available alternative. Therefore, electronic market systems have for some time now embraced the concept and practice of fault tolerant computers, real time redundant storage of critical transaction logs and high availability components. Complimenting this architecture is various approaches to securing redundant physical sites and facilities to provide the assurances of business continuity.



Design Considerations in Electronic Trading Systems

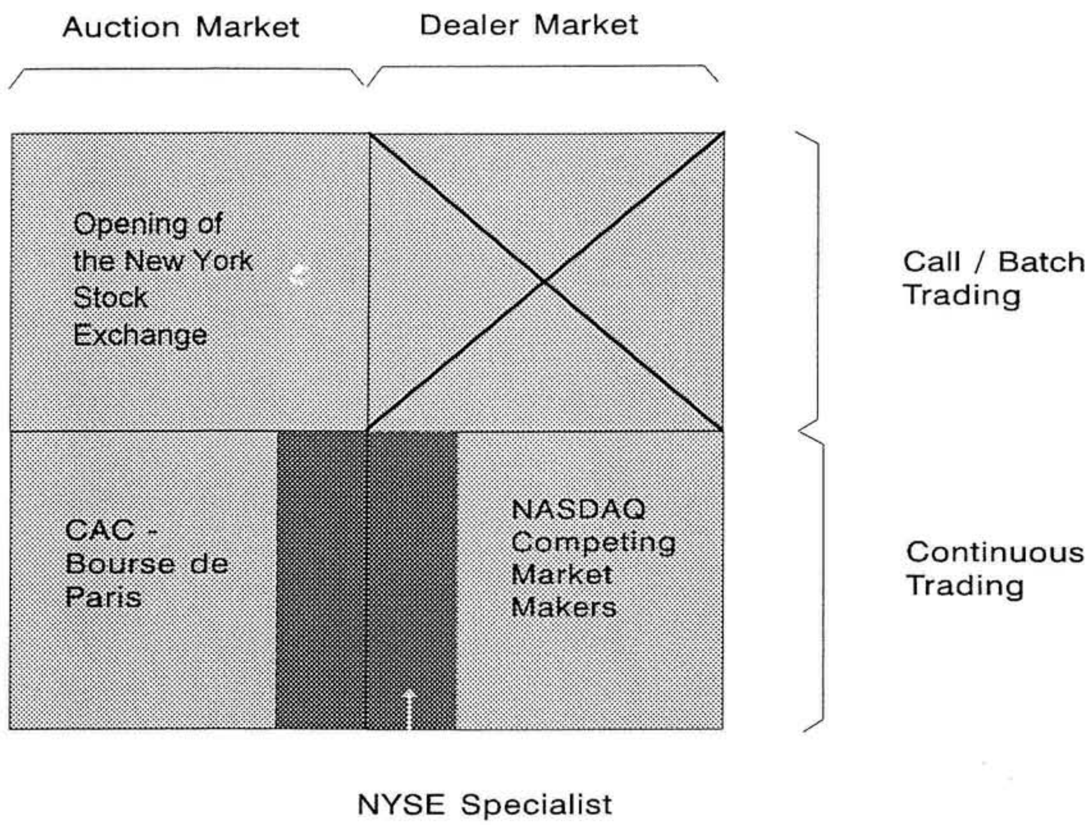
While an important part of the options available in the system's architecture are technological in nature, the design of the electronic trading system software reflects traditional market preferences and business decisions. Issues of efficiency, fairness, customer needs and regulatory constraints have to be addressed. If technology is introduced to support an existing market, its coexistence with the traditional market structure has to be examined. If the system is creating a new market, a wider range of options is available, but careful attention must be given to the system start-up, as in the creation of liquidity, for example. In both cases, however, many facets of the market structure are embedded in the system's design.

Market Structure Implemented

Financial markets exhibit a variety of different operating structures. Despite this diversity, market structures can be classified along two fundamental dimensions: the frequency of trading, and the type of price discovery process. Frequency of trading refers to the distinction between a continuous and a call market. In a continuous market, the securities or contracts traded are continuously priced, that is a trade can occur at any time, providing that the incoming order matches the current price. Prices are characterized by the existence of a spread, the difference between the quoted bid and ask prices (82% of respondents operate continuous markets). In a call market, orders are batched over a predetermined period of time. They are then matched at a given time of the day, at the price that minimizes imbalances between buy and sell orders (32% of respondents operate call markets, either as their only market or in conjunction with a continuous market).

The other dimension, the price discovery process, contrasts the auction market to the dealer market. In the auction market, buy and sell orders are matched continuously at a price that satisfies both parties. Such markets are also called order-driven. Toronto's CATS system, the Tokyo Stock Exchange's CORES system, the proposed Swiss Stock Exchange's system and the NYSE's DOT system are examples of order-driven markets. In a dealer market, a market maker exposes quotes, a bid (sell) price and an ask (buy) price. The prices have to be matched for a trade to execute. Such markets are also called quote-driven. NASDAQ and SEAQ are quote-driven markets.

There is much debate on the benefits and disadvantages associated with each market structure. In a call market, for example, investors may enjoy lower trading costs because they do not bear the bid-ask spread cost. However, they may suffer from a lack of immediate liquidity and thus mitigate this advantage. The market structure is a strategic decision which depends on the type of customers the system is targeting. An electronic call market, for example, can complement a continuous auction floor market and, in fact, does so in many markets where the call procedure is used to set the equilibrium price to start (56% of respondents), restart (40%) and, in some cases, set the closing price for the market (16%).



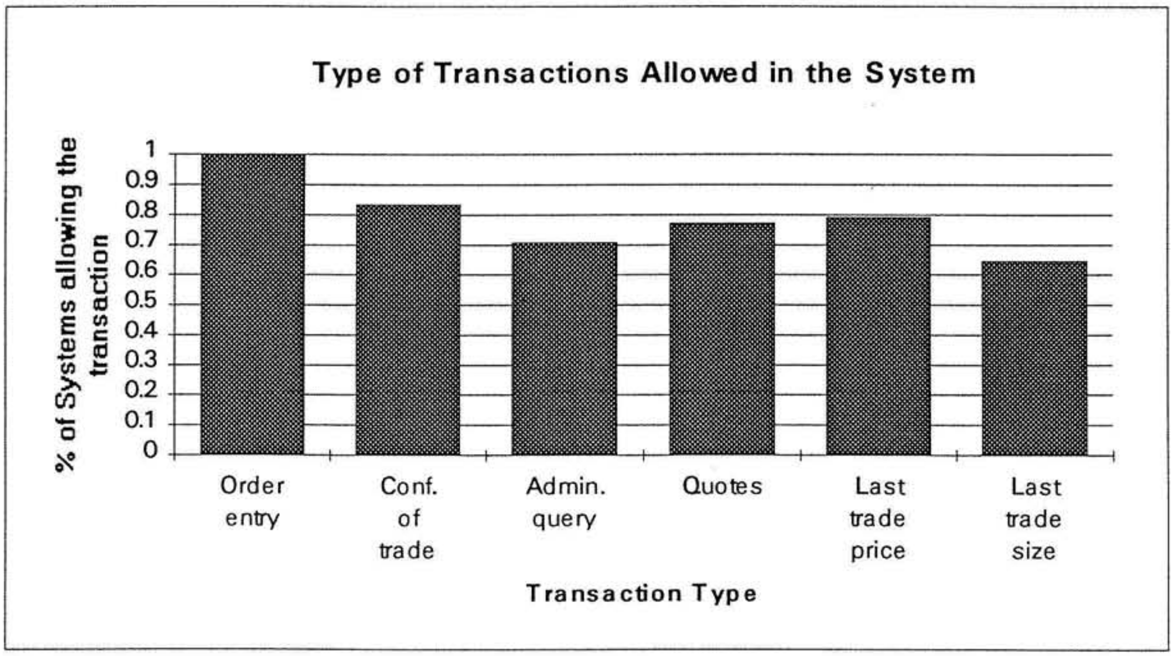
The largest financial markets in the world operate on a continuous trading basis (Stoll 1992). Continuous pricing of securities and the immediacy it provides appears to be an important feature to investors who need to be able to take a position on the market quickly. However, there are practitioners and academics who argue for the economic superiority of the call market structure (Cohen and Schwartz 1988, Schwartz 1991). The core proposition of call market proponents is that it allows for better price discovery, and is more likely to price an instrument at or near its equilibrium price. Improved market efficiency and absence of spread would result in lower costs to the investor. The drawback of this structure is the periodic pricing which may lock investors into unwanted positions. In line with the recommendation of some researchers (Amihud and Mendelson 1988, Cohen and Schwartz 1988), an electronic trading system could offer the best of both worlds. A continuous market which satisfies investors' need for immediacy could co-exist with a single price auction that would offer the benefits of the call market, including lower trading costs and a single price execution for all orders. Technology allows for such systems, with experiments of hybrid market structures being carried out in the US at the Arizona Stock Exchange; and through the proposed MMX system at the Chicago Stock Exchange; in the

Tradepoint system in the UK; and through the PIBAL facility of the Paris Bourse (Jacquillat, Schwartz and Hamon, 1993).

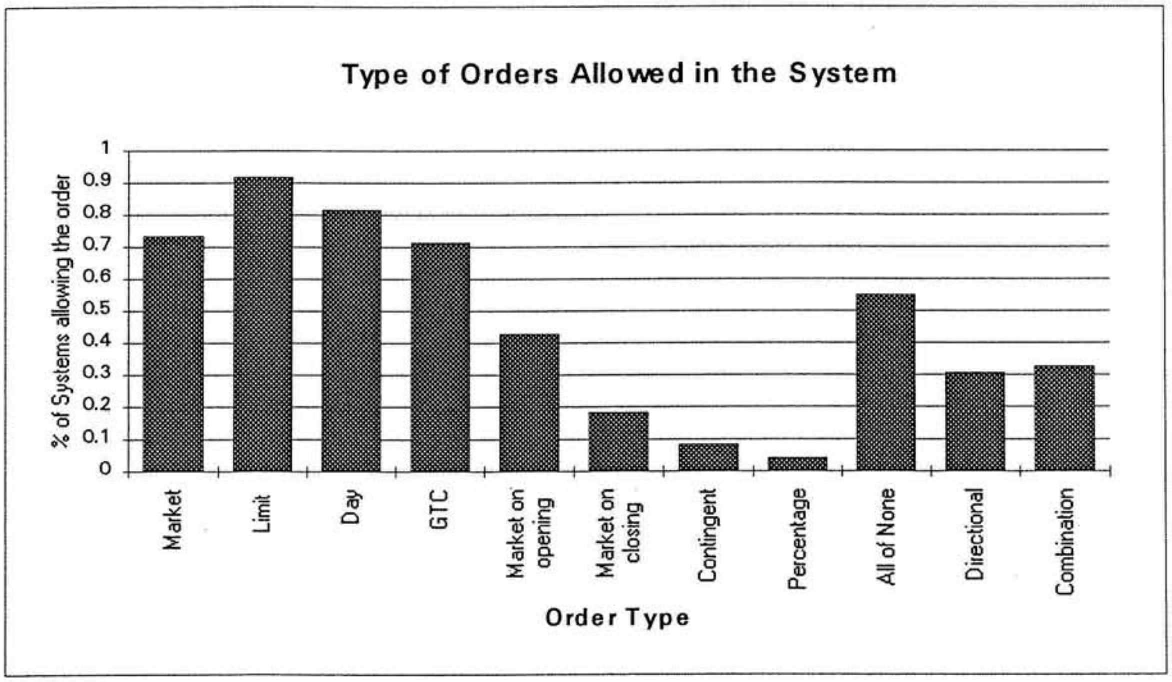
One interesting area to ponder is that many theoretical analyses of financial markets predict equilibrium, stability, integration and concentration (Economides and Siow 1988) in highly interrelated markets, but we observe diversity and fragmentation with increasing numbers of market places. While different structures can serve a wider range of investors' needs, the benefits of this diversity must also accrue to other market participants, including dealers and market makers. An international call for standards of communication, along with theoretical simulations are needed to better understand the reciprocal impact of diverse but electronically linked market places, and the role of technology in standards and market structure evolution.

Type of Transactions

There is a large diversity of transactions accommodated in financial markets systems. These range from the simple queries of where the market is trading at, to what was done with a particular order, to the amount executed and at what price, to the status of a pending order and to the cancellation of non-executed orders.



Other transaction types consist of orders that can be divided into two broad categories: simple orders and contingent orders. Simple orders only depend on the security or contract of interest. Simple orders include market orders, limit orders, day orders, good till cancel (GTC) orders, stop limit orders, market on opening orders, market on closing orders. Contingent orders rely on the value of an external parameter to be executed. An example is an order where execution is contingent upon the value of an underlying instrument, such as an option priced versus an underlying stock, or a parameter, such as volatility. Contingent orders include: percentage orders, which are orders to buy or sell a percentage of the volume of the book, or of the volume of the last transaction; directional orders, which are dependent on market direction, as in the example that an uptick must occur before a short sell order will be accepted; combination orders, which imply simultaneous executions like buying a futures contract in one month and selling the same contract in another month, or buying one security and selling another at a stated price difference.



Contingent orders are more complex to handle than simple orders. It is often difficult to execute these orders electronically because they rely on information which may be external to the system. Some systems, including the NYSE's Specialist Order Book System and the Belgium Futures and Options Exchange system allow contingent orders. However, they have been left out of the systems design, and are handled manually by specially designated brokers. Other exchanges support electronic contingent orders, viewing this capability as a new product. An example is Globex's trading of volatility contracts. Finally, contingent orders may be forced into the system by existing rules or regulation. For example, NASDAQ International, a screen based quotation system that operates in the European time zone for US stocks, is subject to the uptick rule that requires that the closing price of a stock be an uptick for a short sale to be allowed.

The complexity of contingent orders, as well as elaborate trading strategies designed to control investor's risk exposure are a challenge to electronic systems. Moreover, the current trend is to the creation of more, often complex, financial instruments. Existing systems are just beginning to accommodate them, rapid technological progress should allow trading systems to handle a wider range of contingent orders.

Priority Rules - Order Execution Algorithm

The priority rules determine the sequence in which orders are processed once they have been entered into the system. Priority rules are based on the identity of the parties, the type of order, the quantity, the price, the submission time, and the transparency of the order. The table below presents a listing of priority levels found in electronic trading systems (Domowitz, 1992).

Priority Levels in Electronic Trading Systems

• **Price**	priority is given to better prices
• **Price with Improvement**	the order is briefly exposed to the market maker to allow for possible quote improvement
• **Time**	first come, first served
• **Order Type**	priority is a function of the order type: market orders, limit orders, cross orders
• **Order Allocation**	the order is routed to a dealer or market maker, independent of price
• **Quantity/Size Precedence**	priority given to larger or smaller orders
• **Quantity Allocation**	similarly priced orders are equally allocated or pro-rated according to the order size
• **Quantity Identified**	priority given to orders revealing the order size
• **Trader Identified**	priority given to orders that reveal the identity of the trader
• **Trader Class**	priority is given to the public investors over specialists, market makers, or agency brokers
• **Direct Execution**	direct action of accepting the bid or taking the offer

Contrasting Globex with the Automated Pit Trading (APT) system of the London International Financial Futures Exchange provides a good illustration of the implementation of various priority rules. Globex uses a simple price/time matching algorithm: for similarly priced orders, older orders will be executed first. APT does not use the time rule: the algorithm allocates executions among all identically priced orders, without any consideration for the time of arrival.

In most systems, however, price is the highest priority, followed by time (Domowitz, 1992): if two orders are identically priced, the one submitted first will be executed first. It is also important to recognize that the order execution algorithm may not be unique for a given electronic trading system: different market structures may have been implemented, each with a specific order execution algorithm. For example, many markets use a call market procedure at the opening, while the regular trading session is a continuous auction market.

The choice of priority rules implemented in the system can affect both efficiency and liquidity. For example, order priority rules that favor those who submit early limit orders increase the incentive of agents to reveal their private information. The rationale for providing traders higher priority for limit orders submitted earlier is that the early revelation of private information provides better efficiency. Early submission of limit orders will also enhance liquidity. This is especially true in auction markets.

The selection of priority rules must also be considered in light of other market attributes. For example, if the price variation allowed in the market is very small, the value of time priority for limit orders would be limited, for an investor could always get precedence over old limit orders by simply pricing the newly submitted order one increment higher for a buy order and one increment lower for a sell order.

Price Discovery Rules

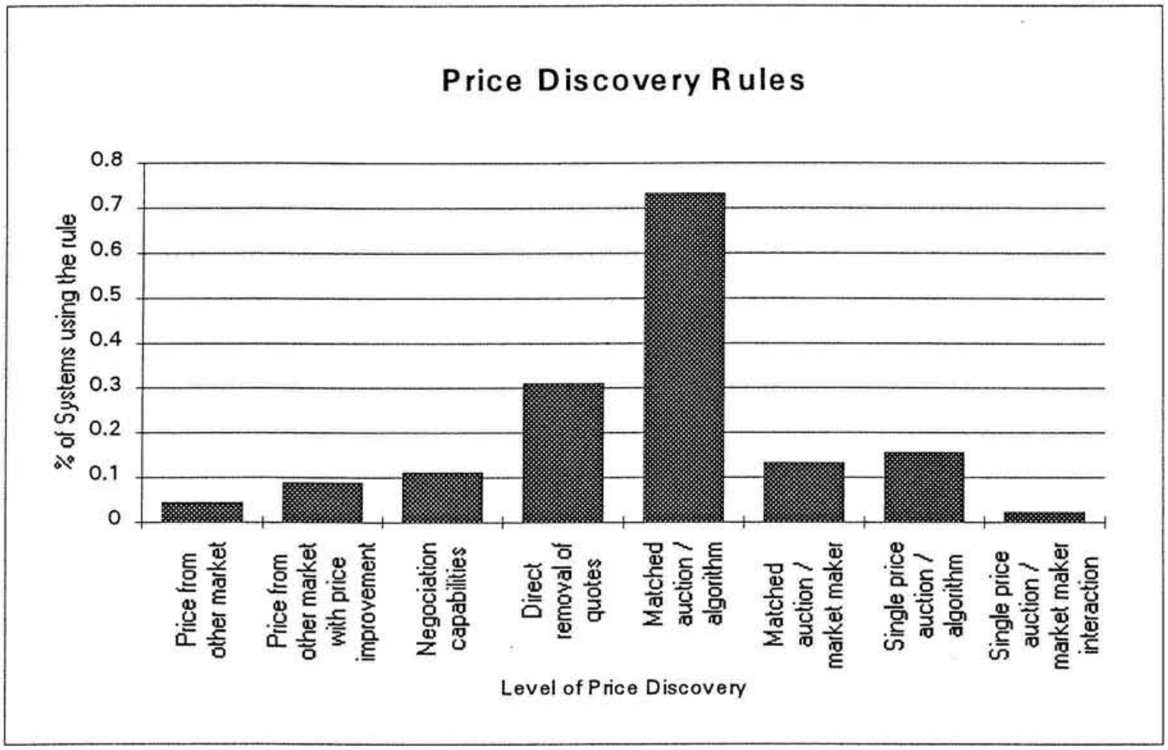
The price discovery process determines the efficiency of the market. It is directly linked to the order matching algorithm. For example, the Instinet Crossing Network executes trades against the closing price from the NYSE, or the mid-spread closing price from NASDAQ. The absence of price discovery here is a direct consequence of the execution algorithm implemented in the system.

The level of price discovery allowed in the system is important, because the ultimate goal of financial markets is to discover the true price of the negotiated security or contract. It also exhibits how much the electronic system depends on the ability of other markets to discover prices. The table below presents an ordered classification of price discovery rules, from the lowest to the highest level (Domowitz, 1992).

A Classification of Price Discovery Rules

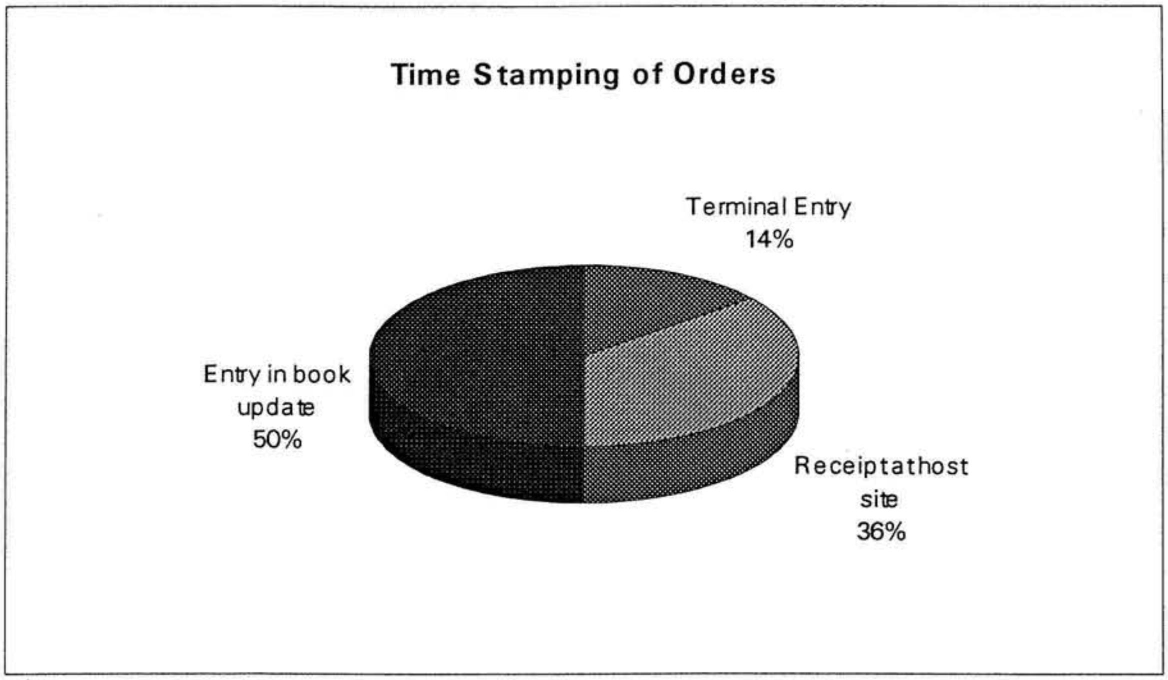
• **Price from another market**	in this situation, there is no price discovery
• **Price from another market with price improvement**	potential price improvement depends on the bid ask spread and market conditions. It can be determined electronically by a trading algorithm
• **Price negotiation**	some level of negotiation is allowed is the system between potential buyers and sellers
• **Electronic quote execution**	executable quotes and quantities based on the best quotes entered into the system.
• **Matched auction**	transaction occurs when the price of the offer to buy matches the price of the offer to sell. The price is: - determined by the system using a matching algorithm - affected by specialist / market maker interaction
• **Single-price auction**	bids and offers are submitted over a period of time, and executed at a single price at a given time. The price is: - determined by system using a balancing algorithm - affected by specialist / market maker-interaction

There are a number of systems that borrow prices from other markets (29% of respondents reported they use such systems). POSIT, the NYSE's after hours crossing service, Instinet's Crossing Network, and the Arizona Stock Exchange borrow prices from the primary markets for equities in the US There is an immediate benefit to use prices from other markets: it waives the costs associated with the price discovery process. This results in lower transaction costs to the investor. However, if a system which relies on prices from other markets draws a lot of volume, less trading will be left to discover prices on the original market. Prices will become less accurate, thereby generating more volatility. And in more fragmented markets, orders will have a lower probability of getting executed (Weber, 1993), which means less liquidity. Overall, investors may have to bear higher trading costs. The "free rider" aspect of systems borrowing prices from other markets may become a concern to regulators if volume builds.

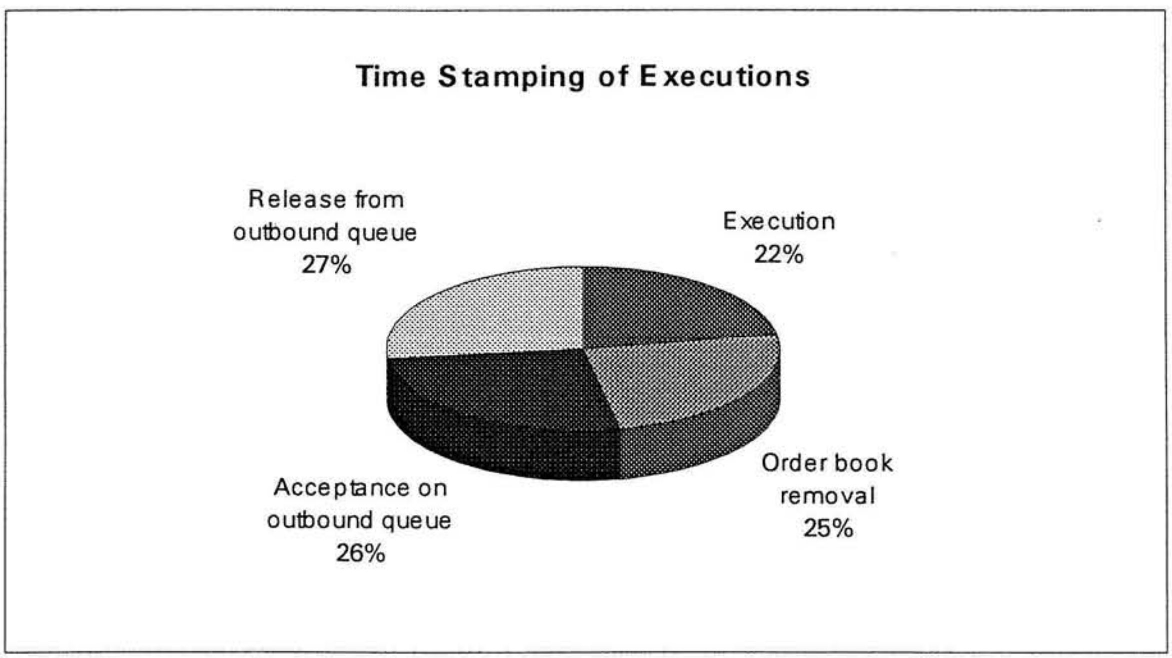


Time Stamping Issues

Time stamping of orders is an important issue, especially in the context of electronic trading. We have seen that most trading systems use time priority to sequence orders identically priced. But a fairness issue is raised if orders are not time stamped properly. As an example two traders, one in New York, and one in Sydney, Australia both want to place a similar order in an electronic trading system located in New York. Due to transmission delays, it is possible that the Australian trader sends the order a few milliseconds before the New York trader, but that it arrives in the system after the New York order. Clearly, the time stamp on the order is of critical importance here. Submitted orders can be recognized as time stamped at time of terminal entry, at time of receipt at the host site, or at time of entry or update in the book. In this example, a time stamp at terminal entry will allow the Sydney order to be processed first, providing that the system has a mechanism for reordering the messages if they are not received in the sequence that their time stamp would suggest. Time stamping at reception at the host site could unfairly favor locally-based traders under high transaction rates.



Similarly, trade executions can be recognized as time stamped at time of execution, at time of order book removal, at time of acceptance on an outbound queue, or at time of release from the outbound queue.



Time stamping issues are not as visible to market participants as the other design attributes discussed earlier. However, they are important to the system designer, especially in situation where market participants are remotely located and/or volume is high. A poor handling of time stamping favoring domestic over international traders could discourage foreign investors from submitting orders in the electronic market.

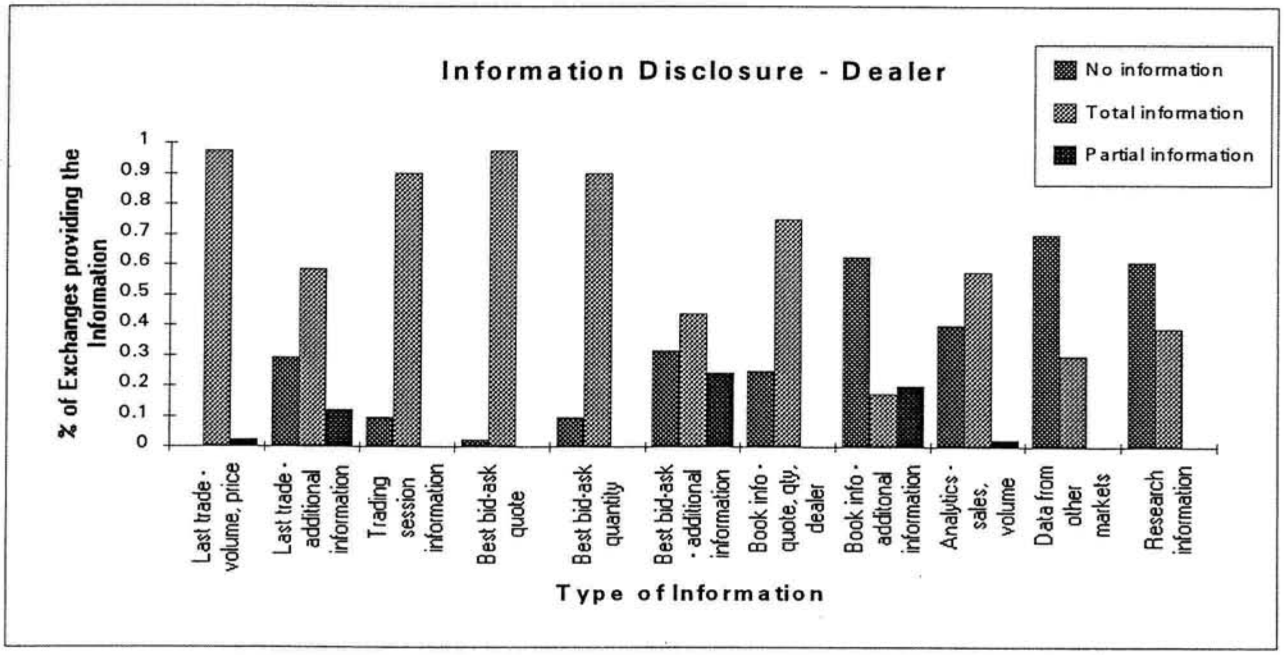
Transparency - Information Dissemination

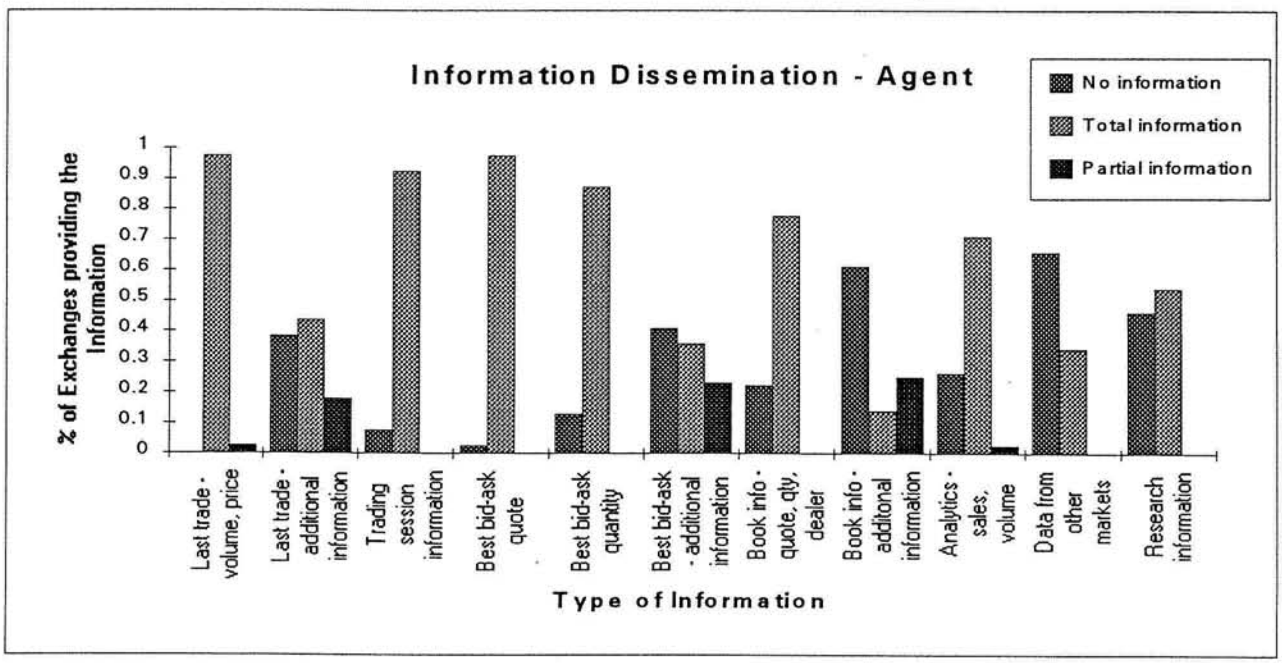
The last important design consideration for an electronic trading system concerns transparency and information dissemination. Access to information by market participants appears to be both desirable and fair. Desirable information access should be evaluated in the context of the "efficient markets hypothesis", which claims that equilibrium prices should fully reveal all available information. Information access to all is fair because privileged information allows its owner to make profits at the expense of less informed investors. However, this is not so simple, and decisions such as who should see specific elements of information impact the efficiency and fairness of the market. The major categories of market participants that should be considered relative to market transparency are market makers, who make two-sided markets, dealers who operate as principals on either side of the market, order book managers (both non-dealing, as with Tokyo's Saitori, and dealing as in the AMEX and NYSE's specialist), agency brokers, and institutional and retail customers. The types of relevant information is shown below.

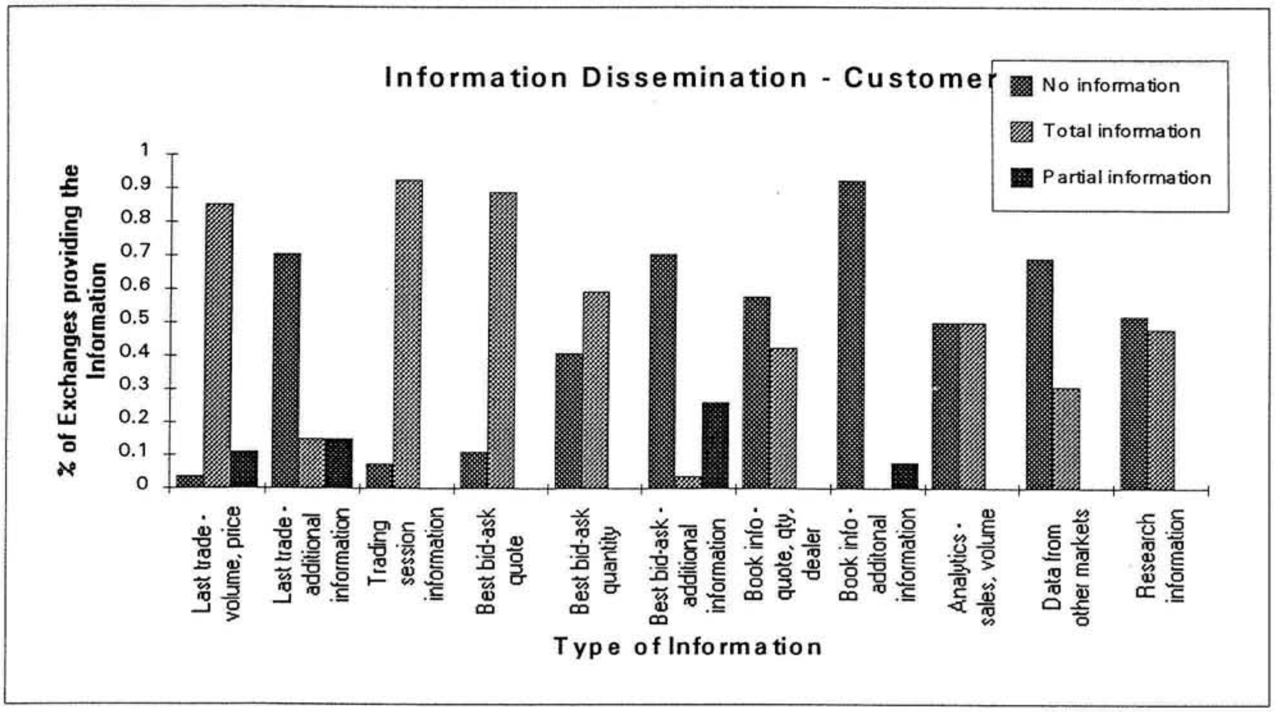
Information Types Observable by Market Participants

• **Last trade information**	volume, price, additional information: identification of the dealer, identification of the counterparty
• **Trading session information (for a given instrument)**	high price, low price
• **Best Bid/Ask quotes (for a given instrument)**	bid/ask quote, quantity, additional information: dealer identification, number of dealers
• **Book information**	quotes, quantities, dealer identification, additional information: counterparty identification
• **Analytic information (for a given instrument)**	sales history, volume history, data from other markets
• **News and research information**	

The transparency of the system, along with the order execution algorithm, are important issues from a regulatory perspective (Corcoran and Lawton, 1993). In the US, the Securities and Exchange Commission (SEC) has a number rules that govern the dissemination of information in the American markets. For example, Rule 11Aa3-1 requires that all US securities exchanges, including NASDAQ, must report last sale information as promptly as possible through the Consolidated Tape System.







One major advantage of electronic trading systems is that trade information is readily available in the system, and can be disclosed immediately to market participants. Rapid information dissemination allows investors to judge the fairness of their own transactions and the momentum of stock prices. The SEC follows this principle and imposes real-time publication of price and volume information on all executed equity transactions. The London Stock Exchange allows a 90-minute delay on trade information disclosure for large trades of 10,000 shares or more. This divergence of view on the fairness issue illustrates the impact that information dissemination decisions can have on the market attractiveness. The 90 minutes shield from reporting obligations was granted to dealers in the London Stock Exchange on large trades to protect them from speculative trading against their inventories. To complete large trades, dealers have to commit their own capital to the purchase of securities. At the completion of the trade, they find themselves with a strong imbalance in their inventory position. They need time to unwind their position, and restore a balanced inventory. Price and volume information disclosure immediately after the trade is made may encourage other dealers to take advantage of these imbalances. Before the application of the 90 minutes delay, "market makers were unwilling to commit their capital. They quoted firm prices for only small quantities of stock. With their capital commitments removed, liquidity fell. Market efficiency suffered, especially for major institutional investors who consider liquidity the most attractive characteristic of a market place. The result was a rise in the cost of capital.[1]"

[1] Unpublished speech by Sir Andrew Hugh Smith, chairman of the London Stock Exchange, to the Workshop of the International Federation of Stock Exchanges, Toronto, June 22, 1992

This brief discussion illustrates the potential impact of information dissemination decisions not only on fairness, but also on liquidity and efficiency of the market. Despite the availability of information provided by electronic trading systems and the claim that immediate information disclosure is only fair to market participants, the system designers must carefully considered which information to disseminate, to whom, and within which time frame.

Conclusion

Technology has led to increased speed and reduced costs of the principally mechanical part of order routing, order processing, and clearing and settlement. Technology has also produced significant changes in trading procedures. Automation has affected trading rules, trading patterns and traditions. It has also affected market transparency and the value of information.

The impact of these new developments are currently being evaluated against the traditional test of market systems - is price discovery and liquidity improved in electronic markets and, if not, are the gains in efficiency in the remaining mechanical process sufficient to sustain their continued development? Or are new paradigms being put in place requiring other measures of a market's validity? Perhaps the dominance of institutional investors in our largest markets and the growth of derivative markets, has permanently changed market expectations? Or has the willingness to invest passively on broad expectations over long time horizons created a two tier market of patient traders and information traders, each with its preference for certain types of market structures?

Electronic market design considerations are made in the context of available technology and the understanding of its constraints and capabilities. These perspectives, along with vision and judgment will determine long term viability, market efficiency, adoption by the financial community and approval by supervisory organizations. We hope this study has served to bring to market executives and technologists an increase in the shared body of knowledge in this area in order to gain new insights and understandings for the future of electronic markets.

FUTURE DEVELOPMENTS of ELECTRONIC MARKETS

Incremental Improvement in System Expected Technology Upgrades Tuning of Performance Funding	Very Significant
Regulatory Concern	Moderately Significant

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