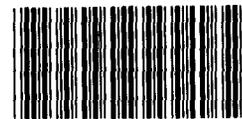


September 1991

# GLOBAL FINANCIAL MARKETS

## International Coordination Can Help Address Automation Risks



144886

---

---



**United States  
General Accounting Office  
Washington, D.C. 20548**

---

**Information Management and  
Technology Division**

B-234478

September 20, 1991

The Honorable Patrick J. Leahy  
Chairman, Committee on Agriculture,  
Nutrition, and Forestry  
United States Senate

The Honorable Donald W. Riegle, Jr.  
Chairman, Committee on Banking,  
Housing, and Urban Affairs  
United States Senate

The Honorable E (Kika) de la Garza  
Chairman, Committee on Agriculture  
House of Representatives

The Honorable John D. Dingell  
Chairman, Committee on Energy and  
Commerce  
House of Representatives

This report presents the results of our review of how major and emerging securities and futures markets operating in the international marketplace use or plan to use automation for the market functions of order routing and execution, information dissemination, and clearance and settlement. It also discusses the risks introduced by the use of automation and the steps these markets are taking to address such risks.

The report recommends that the U.S. regulators—the Securities and Exchange Commission and the Commodity Futures Trading Commission—actively identify and take advantage of opportunities to address automation risks within the international financial community. This could be accomplished through existing international organizations to create an international forum to address automation issues and risks, frame global issues to assure the integrity and reliability of automated systems, and develop global principles and risk-management techniques for world markets to follow. We strongly urge that the Congress support these recommendations, which we believe will help to ensure that securities and futures markets operating in the international marketplace will pursue common solutions to automation risks and that such solutions will benefit all market participants.

---

We are sending copies of this report to the Chairmen of the U.S. Securities and Exchange Commission and the U.S. Commodity Futures Trading Commission, and to other interested parties. Copies will also be made available to others upon request.

---

B-234478

This report was prepared under the direction of Howard G. Rhile, Director, General Government Information Systems, who can be reached at (202) 275-3455. Other major contributors are listed in appendix IV.

A handwritten signature in cursive script that reads "Ralph V. Carlone".

Ralph V. Carlone  
Assistant Comptroller General

---

# Executive Summary

---

## Purpose

Automation is changing the environment in which the world's financial markets operate. Automation, however, introduces risks—risks that can make markets vulnerable to disruption and uncertainty. While some vulnerability is inevitable, automation's ability to adversely affect proper market functioning can be mitigated through effective control. Given the increased use of automation in world financial markets and the importance of efficient and fair operation of world trade, GAO examined how international securities and futures markets use or plan to use automation for three market functions: order routing and execution, information dissemination, and clearance and settlement. Within these functions, particular emphasis was placed on (1) the extent of automation, (2) potential automation risks, (3) regulatory oversight of automation, and (4) methods of global coordination. GAO researched the use of automation with market officials in 13 countries: Australia, Belgium, Canada, France, Germany, Hong Kong, Japan, Luxembourg, the Netherlands, Singapore, Switzerland, the United Kingdom, and the United States.

---

## Background

Securities and futures markets are becoming increasingly automated, global in scope, and interdependent; these developments are being made possible largely by the availability of new computer and communications technology, investors' desires for foreign trading, and corporate actions to raise additional capital from foreign markets. Growth of broker-dealer networks has fueled international trading and enhanced users' abilities to establish positions across markets. Worldwide nondomestic equity trading has grown considerably during the past decade. Foreign gross purchases and sales of U.S. stocks increased from \$80 billion in 1982 to \$361 billion in 1990. During the same period, U.S. gross purchases and sales of foreign stocks rose from \$16 billion to \$253 billion—over a 15-fold increase. Most financial market officials expect this trend to continue. Automated systems have become an integral part of many market activities which, if disrupted, can have significant worldwide ramifications. In this atmosphere, issues such as automation risks and global coordination take on added importance.

---

## Results in Brief

Effective international securities and futures markets require efficient and reliable systems for order routing and execution, information dissemination, and clearance and settlement. Most major and emerging markets have automated or plan to automate all or some of these functions, and all plan to increase their use of automation. This is due to

such considerations as efficiency, competition, and market expansion opportunities.

Most exchanges and clearance and settlement organizations have taken steps to strengthen their controls over automation risks, but such steps vary widely in comprehensiveness. Regulatory oversight of such risks is generally limited worldwide, except for recent, initial steps being taken by U.S. regulators. Finally, although several international organizations have addressed aspects of automation, such efforts have lacked the marketwide coordination needed to systematically reduce the risks introduced by automation—risks that could grow in importance within the next decade as international trading and reliance on automated systems increases.

## Principal Findings

### Automation of Market Functions Increasing

While some of the 32 exchanges in GAO's review still rely on non-automated order routing and execution systems, about two thirds have automated at least part of the function. The use of automated systems for routing and executing orders during business hours and after hours is shown below.

Process	Business hours		After hours	
	Order		Order	
	routing	execution	routing	execution
Automated	21	20	5	4
Nonautomated	11	12	0	1
<b>Total</b>	<b>32</b>	<b>32</b>	<b>5</b>	<b>5</b>

In addition, all of the exchanges use automated information dissemination systems, and all organizations that perform clearance and settlement have either partially or completely automated this function. Reasons for increased use of automation include market efficiency, competition, cost, and expansion.

### Risk Management Varies Considerably

As automation increases, the assurance of a fair and orderly market depends more heavily on the proper functioning of the automated systems in use. For example, markets need to ensure that systems have the

security to prevent unauthorized access and the misuse of data, the capacity to support timely operations, and the controls to provide continuous service in the event of system failure, natural disaster, or intentional malicious act. Without such system controls, markets cannot ensure that they will operate as intended.

Exchanges and clearance and settlement organizations are aware of these critical systems risks and have taken or plan to take steps to address such risks. However, the degree to which such risks are being addressed varies; some automation risks certainly do remain. Shown below are the percentages of the exchanges and clearance and settlement organizations that are implementing risk-management techniques to manage these risks.

<b>Risk management technique</b>	<b>Percentage using technique</b>
Security controls	
Written security plans	43
Risk assessments	70
Capacity planning	
Written capacity plans	46
Contingency arrangements	
Written contingency plans	63
Off-site backup	39
Independent reviews	
Security and contingency	66
Capacity	29

Without a marketwide approach to addressing such systems risks, the proper functioning of the global marketplace may be vulnerable.

### Regulatory Oversight Is Limited

Regulatory structures and attention to automation risks also vary worldwide. Regulators do not generally have the technical capability to oversee this function; indeed, several countries do not have national regulators. All countries rely to some degree on exchanges and clearance and settlement organizations to address automation risks. Foreign regulators have had limited involvement in addressing automation risks and have not issued policy guidance on automation control requirements. However, the U.S. regulators—the Securities and Exchange Commission (SEC) and the Commodity Futures Trading Commission (CFTC)—have

---

taken initial steps to better oversee U.S. market efforts in this important area.

---

## Better Global Coordination Possible

GAO identified six international organizations that are working to improve the operations of financial markets—the Fédération Internationale des Bourses de Valeurs, the Group of Thirty, the International Organization for Standardization, the International Organization of Securities Commissions, the International Society of Securities Administrators, and the Organization for Economic Cooperation and Development. Although all have projects underway that focus on selected aspects of automation, including its risks, they are not focusing—individually or collectively—on an overall marketwide approach to developing systematic, coordinated actions to address the risks associated with automation.

Existing forums could be useful in identifying automation risks and issues and developing guidelines aimed at better addressing such risks. Almost two-thirds of the 52 market officials we asked—including officials of both U.S. regulators—were in favor of an international forum to discuss and assess how to better address the risks associated with automation.

---

## Recommendations

In order to help assure that common solutions are discussed worldwide, GAO recommends that SEC and CFTC actively identify and take advantage of opportunities to address automation risks within the international financial community. This could be accomplished through existing international organizations, which could be useful in (1) creating an international forum to discuss and assess global automation issues and risks; (2) framing the issues in such areas as security, capacity, contingency planning, and independent technical reviews; and (3) developing global principles and risk-management techniques to address automation risks.

---

## Agency Comments

In commenting on a draft of the report, senior officials of CFTC and of SEC's Division of Market Regulation generally agreed with the report's conclusions and recommendations. GAO has incorporated their comments in the report as appropriate. SEC officials said that their comments did not necessarily represent the Commission's views, which will be provided after the final report is issued and reviewed. Although CFTC and

---

SEC do not have authority over the activities of foreign markets, both were asked to comment on the draft report because the recommendations were directed to them.

---

The accuracy and completeness of information in this report covering the activities and practices of other U.S. and foreign entities were confirmed with officials of those entities during the course of GAO's work. These entities were not, however, asked to review and comment on a draft of the report. Instead, specific information reported on individual exchanges, clearance and settlement organizations, and international organizations was reviewed and confirmed by officials representing those entities.

---

# Contents

---

<b>Executive Summary</b>		<b>3</b>
<hr/>		
<b>Chapter 1</b>		<b>12</b>
<b>Introduction:</b>	<b>Automation and Communications Have Increased</b>	<b>12</b>
<b>Automation and World</b>	<b>Globalization</b>	
<b>Financial Markets</b>	<b>Investments in Foreign Markets Have Increased</b>	<b>13</b>
	<b>Growth of Broker-Dealer Networks Has Fueled</b>	<b>15</b>
	<b>International Trading</b>	
	<b>Objectives, Scope, and Methodology</b>	<b>16</b>
<hr/>		
<b>Chapter 2</b>		<b>20</b>
<b>Increasing Market</b>	<b>Order Routing and Execution</b>	<b>20</b>
<b>Uses of Automation</b>	<b>Information Dissemination</b>	<b>25</b>
	<b>Clearance and Settlement</b>	<b>27</b>
<hr/>		
<b>Chapter 3</b>		<b>30</b>
<b>Controls Over</b>	<b>Security Controls Can Prevent Intrusions</b>	<b>31</b>
<b>Automation Risks Can</b>	<b>Capacity Planning Can Ensure Adequate Processing</b>	<b>32</b>
<b>Be Strengthened</b>	<b>Resources</b>	
	<b>Contingency Arrangements Can Ensure Timely Recovery</b>	<b>33</b>
	<b>of Operations</b>	
	<b>Independent Reviews Can Identify Weaknesses</b>	<b>34</b>
<hr/>		
<b>Chapter 4</b>		<b>36</b>
<b>Regulatory Oversight</b>	<b>U.S. Regulators Are Working to Control Automation Risks</b>	<b>36</b>
<b>of Market Automation</b>	<b>Foreign Regulators' Involvement in Addressing</b>	<b>37</b>
<b>Is Limited</b>	<b>Automation Risks Is Limited</b>	
<hr/>		
<b>Chapter 5</b>		<b>38</b>
<b>International Forums</b>	<b>International Groups Addressing Automation Issues</b>	<b>38</b>
<b>and Their Role in</b>	<b>Most Support a Forum on Automation Risks</b>	<b>42</b>
<b>Automation Issues</b>		
<hr/>		
<b>Chapter 6</b>		<b>44</b>
<b>Conclusions and</b>	<b>Recommendations</b>	<b>44</b>
<b>Recommendations</b>	<b>Agency Comments</b>	<b>44</b>

<hr/>		
<b>Appendixes</b>	Appendix I: Objectives, Scope, and Methodology	46
	Appendix II: Organizations Visited During Review	48
	Appendix III: Automated International Links	54
	Appendix IV: Major Contributors to This Report	57
<hr/>		
<b>Related GAO Product</b>		60
<hr/>		
<b>Tables</b>	Table 2.1: Percentages of Automation Used by Exchanges for Order Routing and Execution	20
	Table 2.2: Percentages of Automation Used by Exchanges and Other Organizations for Clearance and Settlement Processes <sup>a</sup>	28
	Table 3.1: Risk Management Techniques Used by Organizations	31
<hr/>		
<b>Figures</b>	Figure 1.1: Gross Purchases and Sales of U.S. Stocks by Investors from Other Countries, 1982-1990	14
	Figure 1.2: U.S. Gross Purchases and Sales of Stocks from Foreign Countries, 1982-1990	15
	Figure 1.3: Locations of Regulators, Exchanges, and Clearance and Settlement Organizations Included in Our Review	18
	Figure 2.1: Trading Floor at the Tokyo Stock Exchange	21
	Figure 2.2: Automated Trading Room at the Tokyo Stock Exchange	22
	Figure 2.3: Trading Floor at the Amsterdam Stock Exchange	23
	Figure 2.4: Trading Floor at the Chicago Board of Trade	24
	Figure 2.5: Video Screens on the Trading Floor of the New York Stock Exchange	26
	Figure 5.1: Market Representatives' Positions on Whether an International Forum Is Needed to Address Automation Risks	42

---

**Abbreviations**

CFTC	Commodity Futures Trading Commission
FIBV	Fédération Internationale des Bourses de Valeurs
GAO	General Accounting Office
GGD	General Government Division
G-30	Group of Thirty
IMTEC	Information Management and Technology Division
IOSCO	International Organization of Securities Commissions
ISIN	International Securities Identification Number
ISO	International Organization for Standardization
ISSA	International Society of Securities Administrators
MATIF	Marche à Terme International de France
NASD	National Association of Securities Dealers
NSCC	National Securities Clearing Corporation
OECD	Organization for Economic Cooperation and Development
SEC	Securities and Exchange Commission
SICOVAM	Société Interprofessionnelle pour la Compensation des Valeurs Mobilières

---

---

---

# Introduction: Automation and World Financial Markets

---

Securities and futures markets are becoming increasingly international, reacting to many of the same economic and political events that affect the rest of the world. The globalization of these markets is driven by several factors, but advances in automation and telecommunications have propelled its rapid growth. Factors driving this globalization include the growth of large institutional funds needing to decrease risk by diversifying investments in other countries, and regulatory changes that opened markets to foreign broker-dealer firms and their customers. Although isolated market conditions can occur, market interdependence was demonstrated by the 1987 market crash, the 1989 market decline, and market reaction to this past year's Persian Gulf crisis.

---

## Automation and Communications Have Increased Globalization

Advances in computer technology and telecommunications are key factors in the expansion of international trading. Such advances have made possible the emergence of a global communications infrastructure that permits the efficient and rapid transmission of market data. According to an Office of Technology Assessment report, the four technological trends contributing to this development have been the

- expansion of computer capability and reduction in costs,
- digitalization of data and the resulting convergence of computer and telecommunications technologies,<sup>1</sup>
- development of satellite communications, and
- development of fiber optics.<sup>2</sup>

According to a former New York Stock Exchange vice president of equity systems, changes in telecommunications have increased the volume of data and reduced the time and cost involved in transmitting it around the world. He cited the early-1990 installation of a fiber-optic cable link between the United States and Japan, which has greatly reduced the cost of communication and has changed the economics of transmitting trade data.

---

<sup>1</sup>Digitalization is the translation of information from traditional analog forms such as pictures, speech, or written characters, into discrete binary-coded electronic signals for processing, storage, or transmission.

<sup>2</sup>Trading Around The Clock: Global Securities Markets and Information Technology - Background Paper, Office of Technology Assessment, U.S. Congress, July 1990.

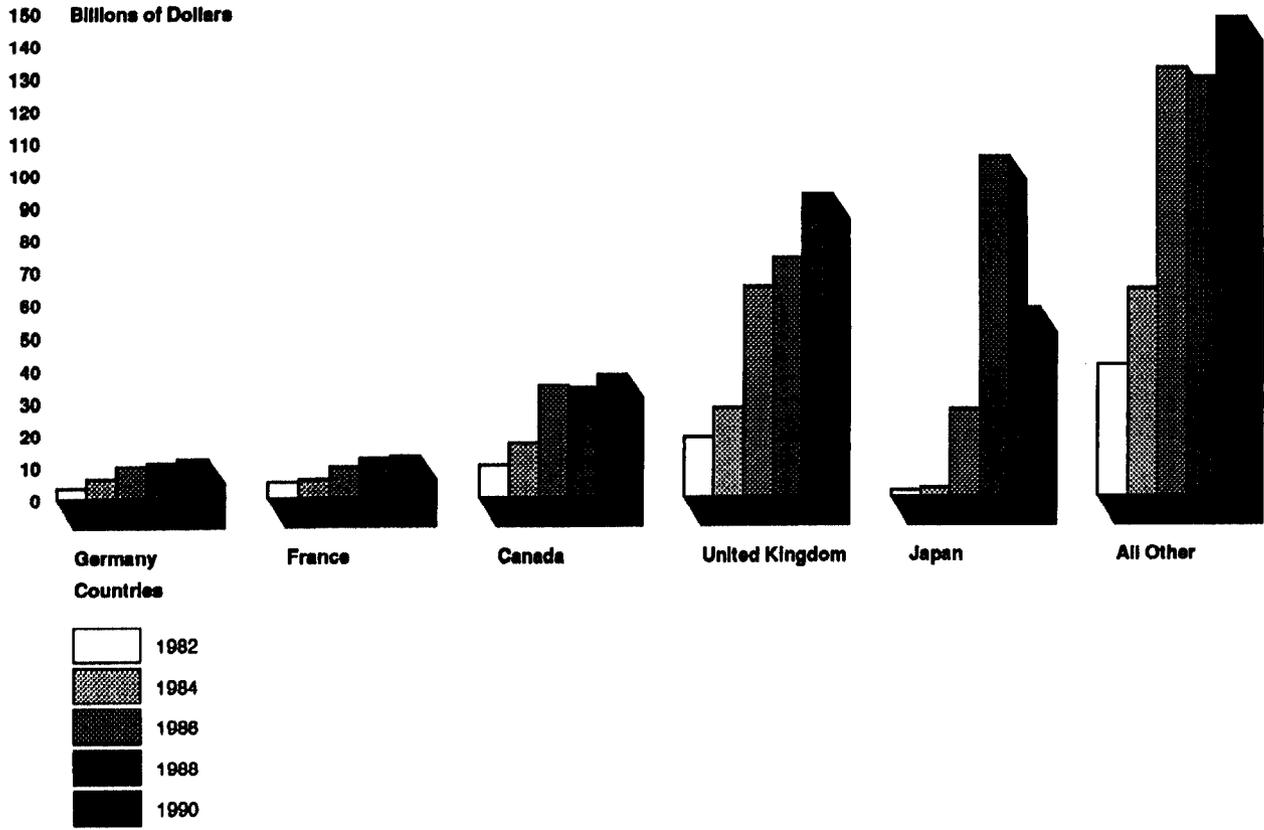
---

## Investments in Foreign Markets Have Increased

The growth of institutional investment funds in the United States, such as pension and insurance funds, has been a major force behind international trading. These funds represent large concentrations of capital used by investment managers to diversify holdings outside the United States as a hedge against such market risks as adverse currency fluctuations and domestic economic recessions. According to the Office of Technology Assessment, the value of cross-border portfolio investments by U.S. private-sector pension plans grew from \$21 billion in 1980 to \$225 billion by the end of 1988—more than a ten-fold increase. In addition, the Securities Industry Association reported that worldwide non-domestic equity trading in 1989 accounted for over 11 percent of total worldwide trading, up 2 percent from 1988. Officials of securities and futures markets we talked with generally agreed that the growth in global trading will continue in the 1990s.

The internationalization of markets is further demonstrated by figures on the foreign gross purchases and sales of U.S. stocks in Japan, the United Kingdom, and other major foreign markets. Figure 1.1 shows the increase in such trading during the 1980s.

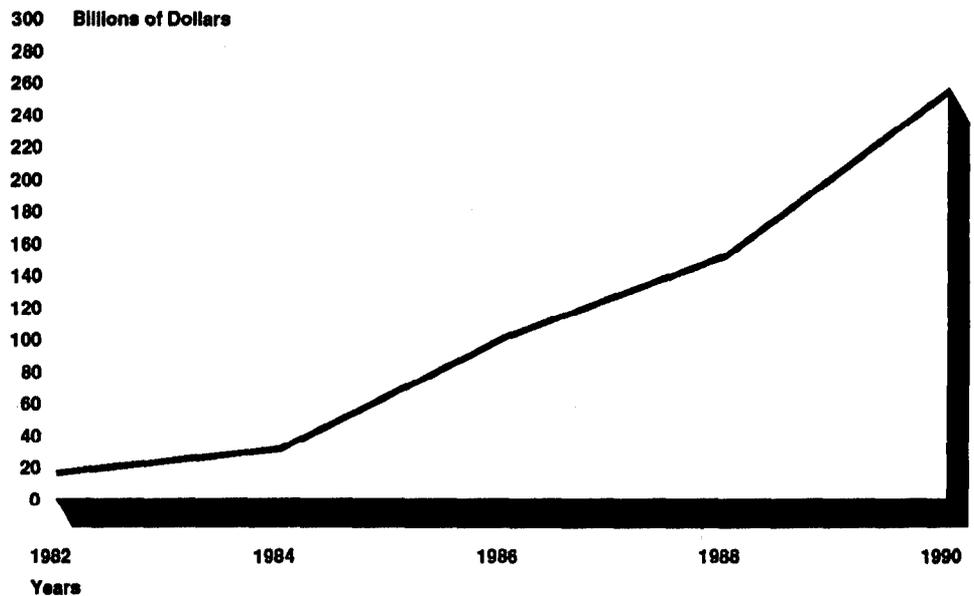
Figure 1.1: Gross Purchases and Sales of U.S. Stocks by Investors from Other Countries, 1982-1990



Source: U.S. Treasury Bulletin (various issues).

The figures on U.S. gross purchases and sales of stocks from major foreign markets also demonstrate the internationalization of the markets. Figure 1.2 depicts how such trading grew during the 1980s.

**Figure 1.2: U.S. Gross Purchases and Sales of Stocks from Foreign Countries, 1982-1990**



Source: U.S. Treasury Bulletin (various issues).

## Growth of Broker-Dealer Networks Has Fueled International Trading

Securities and futures markets have become more open to foreign participation through liberalization of laws and financial market policies. For example, securities markets in the United Kingdom, France, and Spain were deregulated during the latter part of the 1980s, allowing foreign firms greater access and growth. Further, in 1989 Japan's Ministry of Finance made regulatory changes to broaden Japanese investor access to foreign futures and options markets by allowing certain Japanese banks and firms to buy and sell foreign futures and options for Japanese clients. In 1990, Japan's Commodity Exchange Act was revised to enable foreign firms to obtain memberships in Japanese commodity futures exchanges, and to allow foreign futures traders to accept orders from Japanese customers for markets outside Japan.

Market openness has also been furthered by the movement of foreign broker-dealer affiliates into these markets. Broker-dealer firms have developed a variety of techniques to trade throughout the world's financial markets. These techniques range from routing orders by telephone, telex, or facsimile machine to using fully automated networks to route orders from any broker's office throughout the world to the appropriate foreign market or to an affiliate broker's office to execute a trade.

Such networks were developed by broker-dealer firms in response to market participants' needs to expand their holdings and capital bases to participate in cross-border trading activities. During the mid-1980s, some broker-dealer firms established affiliate offices in other countries, which became members of foreign exchanges and began to expand due in part to changes in laws and exchange policies. This presence allowed them to trade domestically on those particular markets, as well as to receive orders and conduct trades for international clients. For instance:

- From December 1984 to September 1989, the number of foreign broker-dealer firms licensed to engage in Japan's securities business increased from 10 to over 50.
- From December 1984 to December 1989, the number of foreign broker-dealer firms listed with the U.S. Securities Industry Association that trade securities in the United States increased from 22 to over 50.

## Objectives, Scope, and Methodology

Three of our recent reports address the steps taken by U.S. markets to deal with the risks associated with automation.<sup>3</sup> This review was initiated in anticipation of increased congressional interest in the use of automation in international financial markets, and in whether these markets, which are becoming increasingly interdependent, are working cooperatively to control automation's risks. Specifically, our objectives included identifying the (1) automated systems and electronic links being used and planned by exchanges and clearance and settlement organizations in these markets, (2) steps markets are taking to address the risks of automation, (3) extent of regulatory oversight of automation issues provided by financial market regulators, and (4) automation issues being addressed by international organizations.

We conducted our work in 13 countries: Australia, Belgium, Canada, France, Germany, Hong Kong, Japan, Luxembourg, the Netherlands, Singapore, Switzerland, the United Kingdom, and the United States. In these locations we met with key securities and futures market officials of 32 exchanges and 17 clearance and settlement organizations.<sup>4</sup> Figure 1.3 illustrates the locations of the regulators, exchanges, and clearance

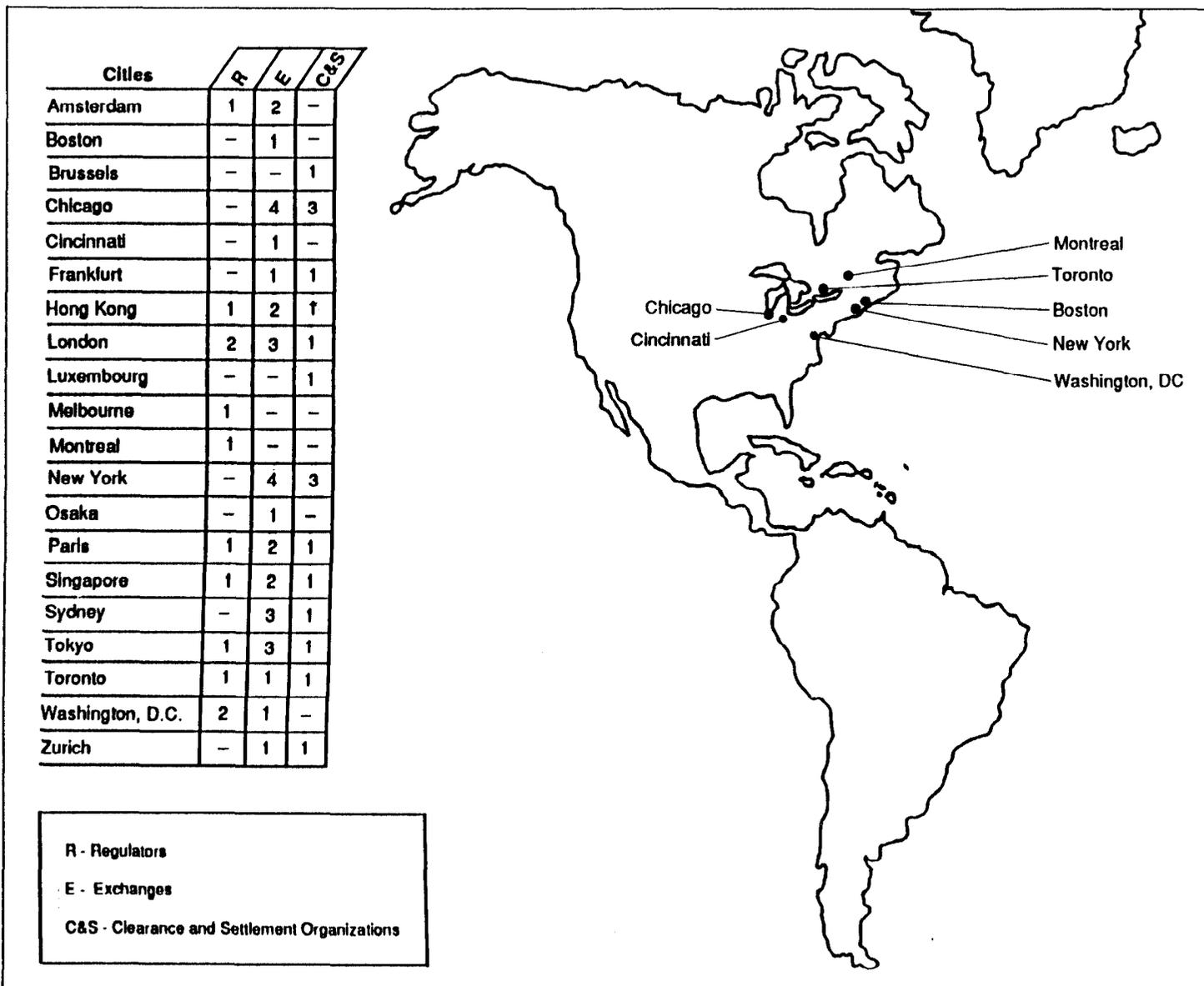
<sup>3</sup>Financial Markets: Active Oversight of Market Automation by SEC and CFTC Needed (GAO/IMTEC-91-21, Apr. 2, 1991); Stock Market Automation: Exchanges Have Increased Systems' Capacities Since the 1987 Market Crash (GAO/IMTEC-91-37, May 10, 1991); and Financial Markets: Computer Security Controls at Five Stock Markets Need Strengthening (GAO/IMTEC-91-56, Aug. 28, 1991).

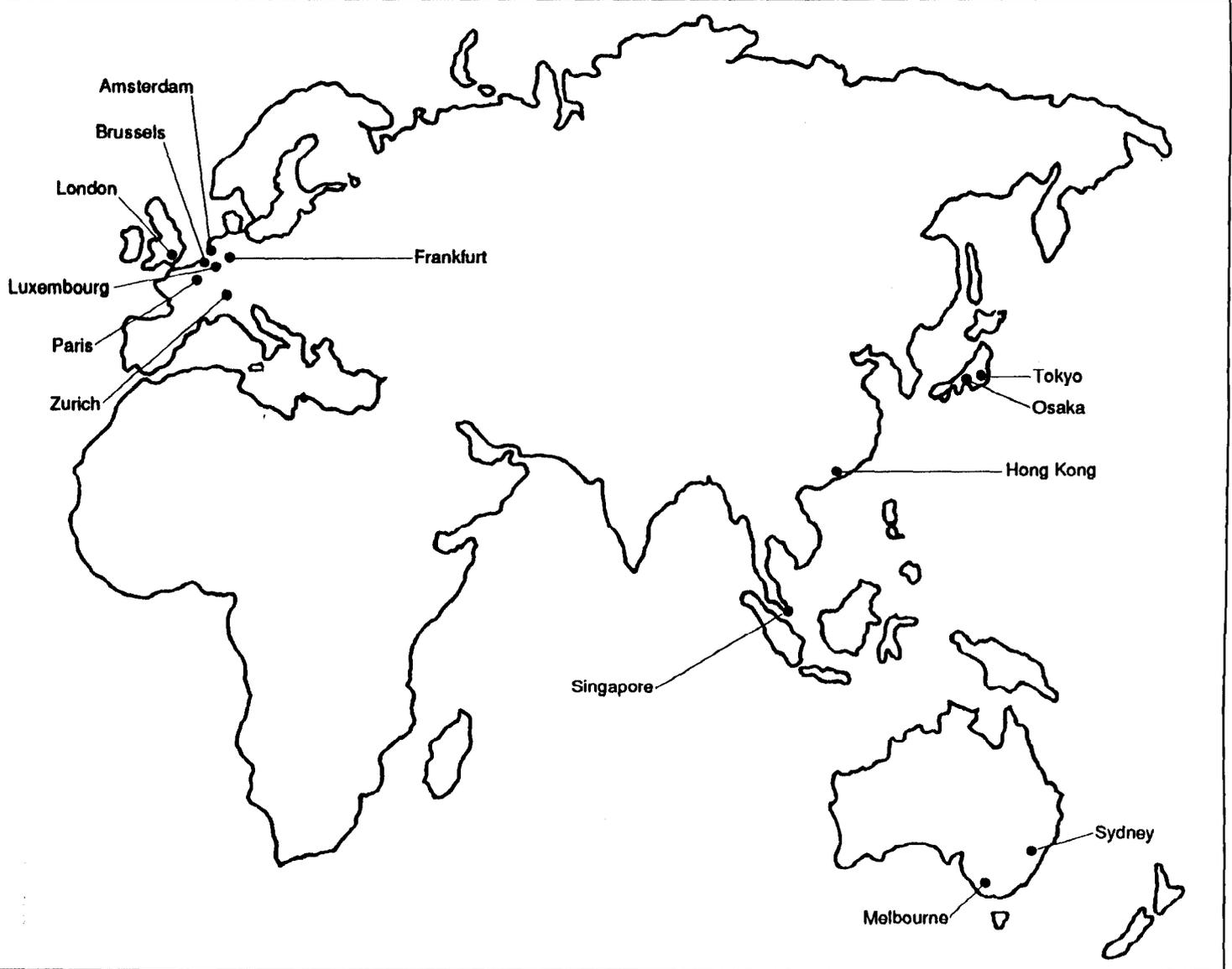
<sup>4</sup>For purposes of this report, the National Association of Securities Dealers is categorized as an exchange.

and settlement organizations included in our review. We also met with 12 market regulators, 28 broker-dealer firms, and 23 other market participants. A detailed description of our objectives, scope, and methodology is contained in appendix I, and a listing of organizations visited is in appendix II.

In discussing organizations' data processing operations and their practices to address risks, we relied primarily on testimonial evidence. We did not attempt to independently verify this information in the foreign countries we visited. Except for this limitation, we conducted our review in accordance with generally accepted government auditing standards. This work was performed from April 1990 through June 1991.

Figure 1.3: Locations of Regulators, Exchanges, and Clearance and Settlement Organizations Included in Our Review





# Increasing Market Uses of Automation

Automation is clearly enhancing the ability of the financial marketplace—exchanges, clearance and settlement organizations, broker-dealer firms, and information disseminators—to carry out major trading functions: order routing and execution, information dissemination, and clearance and settlement. Most use automation heavily and all plan to introduce, expand, or upgrade automation in one or more of the trading functions.

## Order Routing and Execution

The primary trading function, order routing and execution, includes two basic processes: (1) routing customers' buy and sell orders from broker-dealer firms to exchanges and routing trade results back to firms; and (2) executing trades. Table 2.1 shows that most of the 32 exchanges in our review use some automation for these processes during normal business trading hours; five with after-hours trading also use automation.

**Table 2.1: Percentages of Automation Used by Exchanges for Order Routing and Execution**

Process	Percentage fully automated	Percentage partly automated <sup>a</sup>	Percentage nonautomated (manual)
Business hours			
Routing orders	16	50	34
Trade execution	18	44	38
After hours			
Routing orders	80	20	•
Trade execution	80	•	20

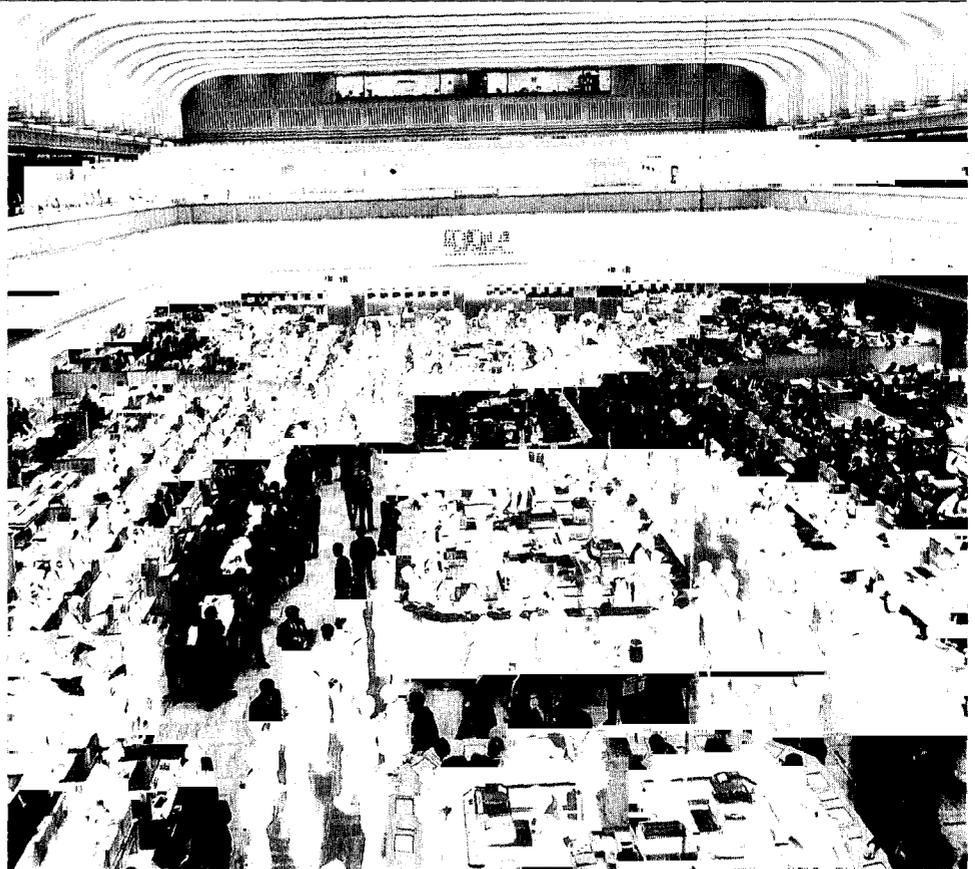
<sup>a</sup>Partly automated ranges from those exchanges that use very little automation to those that are almost fully automated. It also includes exchanges that use automation as an alternative to manual processes.

Automation is used by exchanges to improve trading efficiency by expediting the process, reducing processing errors and unmatched trades, and offering greater protection from unfair trading practices. Some, such as the Australian and Cincinnati stock exchanges, use automated order routing and execution systems for all trades; others, such as the Zurich, Geneva, and Basel stock exchanges (associated in the Association Tripartite Bourses) in Switzerland and Commodity Exchange in New York, employ nonautomated operations for order routing and execution.

The remaining exchanges use automation to assist in the trading processes (e.g., for selected trading volumes, to extend operating hours, to provide an alternative to their floor trading, or for certain processes). For example, the Tokyo Stock Exchange uses order-matching members

referred to as Saitori members<sup>1</sup> to execute trades on its electronic books and automated trading systems. The exchange's top 150 stocks (by volume) are traded on electronic books used on the trading floor. Orders up to 3,000 shares can be automatically routed to the electronic books from broker-dealer firms or booths on the floor, while orders over 3,000 shares are manually routed from broker-dealer booths to Saitori members, who input them into the books. Additionally, orders for the approximately 1,600 remaining stocks and all options and futures contracts are automatically routed to trading rooms for execution on automated trading systems. Figures 2.1 and 2.2 depict the Tokyo Stock Exchange's trading floor and automated trading room, respectively.

**Figure 2.1: Trading Floor at the Tokyo Stock Exchange**



Courtesy the Tokyo Stock Exchange.

<sup>1</sup>Saitori members are nontrading, licensed brokers who facilitate trade matching between regular trading members. They input instructions into the electronic books and automated trading systems to execute trades when buy and sell orders are displayed at the same price.

**Figure 2.2: Automated Trading Room at the Tokyo Stock Exchange**



Courtesy the Tokyo Stock Exchange.

**In other examples:**

- The London International Financial Futures Exchange and the New York Stock Exchange use automated order routing and execution systems for all after-hours trading while maintaining partially automated systems and floor trading during the work day.
- The Chicago Board Options Exchange has an automated order routing and execution system that can be used for small orders; such orders can also be traded in the traditional manner on the floor.
- The Amsterdam Stock Exchange has an automated order routing system that transmits customer orders directly to the trading floor for execution; however, trade executions are performed by a specialist with the assistance of automated applications on the trading floor. Figure 2.3 shows the trading floor at the Amsterdam Stock Exchange.

Figure 2.3: Trading Floor at the  
Amsterdam Stock Exchange



Courtesy the Amsterdam Stock Exchange.

Representatives of the 32 exchanges see various benefits in automated systems, including better control of operational costs, more efficient market operation, better market information, greater opportunity to expand products and trading hours, preparation for future automated trading links, and the assurance of market fairness. The exchange officials told us they plan to introduce, expand, or upgrade their use of automation for order routing and execution and provided us with information on such plans. The following are examples of planned automation these officials identified:

- The American Stock Exchange, Chicago Board Options Exchange, and Cincinnati Stock Exchange also plan to develop an after-hours electronic system for worldwide trading of their products.
- The Chicago Mercantile Exchange, Chicago Board of Trade, and Marche Terme International de France (MATIF) plan to use an automated trading system, called GLOBEX, for worldwide trading of their futures contracts after normal trading hours.
- The Chicago Mercantile Exchange and the Chicago Board of Trade are also jointly developing automated hand-held trading terminals to augment their open-outcry trading process. The terminals will be designed to electronically receive orders, automatically record the time and other details of each trade as it occurs, and electronically transmit trade results to a main computer for further processing. Figure 2.4 shows a Chicago Board of Trade trading floor where the hand-held terminals are planned to be used.

**Figure 2.4: Trading Floor at the Chicago Board of Trade**



Courtesy the Chicago Board of Trade.

---

## Direct Electronic Links Are Not Prevalent

Although markets have become more global and interdependent, direct international electronic order routing and execution links between exchanges have not progressed as originally envisioned. Until recently, officials saw such links as a future trend in financial markets, but the links have not proved as successful or far-reaching as once thought. In general, the links have failed to generate the volume of trades or revenues anticipated; two established trading links have recently become inactive.

No broker-dealer firms in our review rely on exchange-to-exchange links to perform their international trading. Most of the 28 firms believe that global trading will continue to grow but that such growth will be primarily through their own networks of offices and systems, rather than through direct links between exchanges. For example, one broker-dealer firm said that exchange-to-exchange links will never replace the need for broker-dealer firms to establish a physical presence in markets. Another said that its foreign affiliates will have superior knowledge of that particular market and will therefore be able to provide its clients with the best service for their needs in that market. Appendix III provides further information on the active, planned, and discontinued links identified by exchange officials.

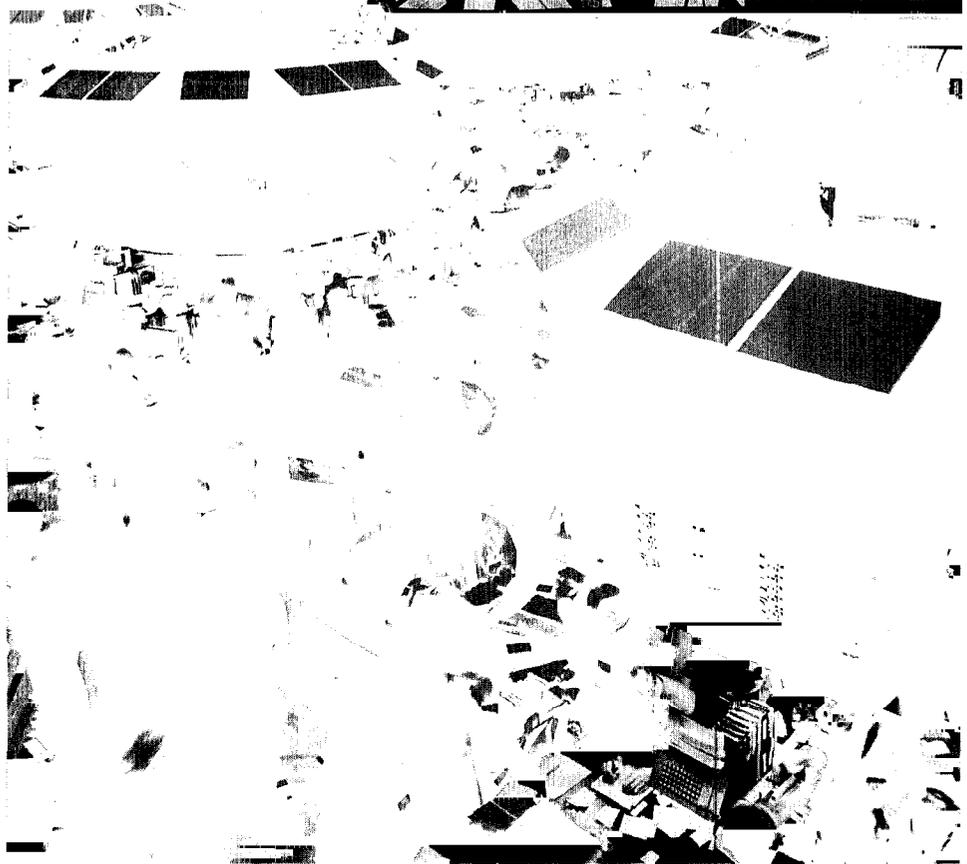
---

## Information Dissemination

The collection and distribution of trading data to market participants comprises what markets term information dissemination. Such data include information on trades, prices, volume, and quotes. Because of the time-critical nature of trading data in investment decisionmaking, automation is used heavily to collect and disseminate accurate trading information on a real-time basis. Automation can provide all market participants with equal access to the same market data—at the same time—that are available to traders on exchange floors and trading systems. Automated information dissemination systems can promote the effective operation of markets, and can be particularly crucial in times of market volatility, when up-to-the-minute trading data may be necessary to avert panic.

All 32 exchanges use automated systems to some degree to disseminate market information. At 17 exchanges information is collected and distributed through completely automated systems. These systems collect market data such as the asked, bid, and selling prices. These data are then distributed electronically to display boards, video screens, computer terminals, and information dissemination vendors. Figure 2.5 shows some of the video screen displays on the trading floor of the New York Stock Exchange.

**Figure 2.5: Video Screens on the Trading Floor of the New York Stock Exchange**



Courtesy the New York Stock Exchange.

In the 15 other exchanges the collection of market trade data is partially automated. For example, some exchanges, such as the London International Financial Futures Exchange, use employees on trading floors to observe trades and record trade data. These employees then transmit the data—by hand signal, telephone, or wireless headset—to other exchange employees, who enter them into automated information dissemination systems for electronic distribution to display boards, video screens, computer terminals, and information dissemination vendors.

Commercial vendors play a vital role in disseminating trading data to exchanges and to market participants. They receive trade data from exchanges and then transmit it to their customers. All six of the information dissemination vendors visited use automated systems to receive and disseminate market information. These vendors use data processing systems to provide a diverse range of up-to-date market information and

other services to their customers. For example, Switzerland's TELEKURS AG, according to its officials, takes real-time market information from over 140 markets and other contributors (e.g., banks) around the world, routes it to a central processing site, then validates, reformats, and transmits it to customers—all within 3 to 5 seconds.

Representatives of the 32 exchanges and 6 information dissemination vendors agree with the benefits of automation previously stated under order routing and execution and provided us with information on their plans to expand or upgrade their use of automation in this area. The following are examples of some planned automation that these officials identified:

- Switzerland's TELEKURS AG is upgrading its systems to offer an improved market data feed in digital format, covering the requirements of users in both Europe and the United States. This will enable its customers to process the received data more efficiently.
- Quotron is upgrading some of its information feeds to digital feeds in order to build additional capability to accept and distribute data. The distribution upgrade will enable customers to write their own application programs to format and analyze the data themselves.

When asked to provide information on exchange-to-exchange information dissemination links, exchange officials identified a few such links (see app. III).

---

## Clearance and Settlement

Clearance and settlement takes place after trades have been executed. The clearance and settlement processes include: (1) receiving trade information, (2) matching trades to confirm the terms of buyers and sellers, (3) calculating the payments owed by and due to the traders, and (4) initiating the payment of funds by traders (and in the case of stocks, transferring ownership from sellers to buyers).

Eighteen of the exchanges in our review clear and settle their own transactions; nine exchanges perform some of these functions and the remaining five rely completely on clearance and settlement organizations to perform all these functions. We included 17 clearance and settlement organizations in our review. Table 2.2 shows the percentages of use of automation by the 49 organizations for their clearance and settlement processes.

**Table 2.2: Percentages of Automation Used by Exchanges and Other Organizations for Clearance and Settlement Processes<sup>a</sup>**

Process	Percentage fully automated	Percentage partly automated	Percentage nonautomated (manual)	Percentage not performed
Receiving trade data	59	14	2	25
Matching trades	67	6	2	25
Calculating payment	49	12	4	35
Initiating payment	18	18	23	41

<sup>a</sup>Not all organizations perform all of these processes.

The National Securities Clearing Corporation (NSCC), which clears over 90 percent of the stocks traded in the United States, is automated. Through automated links, NSCC receives locked-in trades (matching is not necessary) and unmatched trade data, which it processes through its automated trade comparison systems. Each broker-dealer firm's obligation to receive or deliver securities is netted on a daily basis. The transfer of ownership of most securities is handled through a computer-to-computer link with the Depository Trust Company, which maintains securities accounts for broker-dealer firms and banks and effects the delivery of securities by automated book entry. However, some securities are still transferred manually and the settlement of funds through NSCC is also done manually by physical delivery of checks.

An example of an exchange that has a partially automated clearance and settlement function is the Stock Exchange of Hong Kong. Exchange brokers verify the details of their trades, which are recorded in the exchange's automated system. The calculation of traders' obligations is performed on a trade-by-trade basis, the transfers of securities ownership are done manually by physical delivery, and payments are likewise made manually by delivery of checks. We were told, however, that a clearance and settlement organization had been established and that an automated system was under development.

As with the other market functions described in this chapter, officials of exchanges and clearance and settlement organizations see the same benefits in the increased use of automated systems. More efficient and faster trade comparisons was also identified as a benefit. These officials provided us with their plans to increase or upgrade the use of automation in the clearance and settlement area. The following are examples of planned automation that these officials identified:

- Australian Stock Exchange officials are developing a system to electronically link their exchange with its members, institutional investors,

banks, and share registries to allow book entry settlement of securities and payment transfers through the banking system's funds transfer network.

- An automated clearance and settlement network is under development that will link various types of brokers, banks, and the Stock Exchange of Hong Kong to the Hong Kong Securities Clearing Company, Limited.
- The Canadian Depository for Securities plans to automate a previously manual interface process between the depository's participants and issuers or agents who cancel stock certificates or bonds when they are sold and reissue new certificates to the new owners. The automation will involve electronic message communications for title transfers and an automated tracking system.

When asked to identify any automated links with others for purposes of clearance and settlement, exchange and clearance and settlement organization officials said that links for this function are seen as a future trend in financial markets, but that, as with links for the other market functions, they have not grown as rapidly as first anticipated (see app. III).

Officials of the 28 broker-dealer firms included in our review said that they generally do not rely on the clearance and settlement links that have been established to assist them in processing executed international trades, although they do at times use the links. Many said that the links are not heavily used because the clearance and settlement services in place in the home country where the trade is executed are used instead.

There are many benefits to the use of automation in the financial marketplace, and it is clear that markets' use of automation will continue to increase. How they manage the automation-related risks that come with such growth will play a large part in determining the future success—and perceived safety—of individual markets and the international financial marketplace as a whole.

# Controls Over Automation Risks Can Be Strengthened

---

While world financial markets rely increasingly on automation, automated systems introduce risks that can make markets vulnerable to disruption and uncertainty. While some vulnerability is inevitable, adverse effects to proper market functioning can be mitigated through appropriate controls.

As we reported in April 1991, such controls are needed to ensure that U.S. securities and futures markets have adequate (1) security to prevent unauthorized access and misuse of data, (2) capacity to support timely operations, and (3) programs to provide continuous service in the event of system failure, natural disaster, or intentional malicious act.<sup>1</sup> Further, we believe that markets can benefit from independent technical reviews to confirm that their systems perform as intended. Because world markets are becoming more interdependent and the risks associated with automation are universal, the benefits that adequate controls can provide extend beyond U.S. borders, to all financial markets worldwide.

Officials of most exchanges and clearance and settlement organizations in our review are generally cognizant of the automation risks associated with inadequate security, capacity, contingency programs, and independent technical reviews. While time and other constraints precluded our discussing all four areas with each of these officials, the information we did obtain indicates that control levels in place vary considerably, and further, that automation risks associated with inadequate security, capacity, contingency planning, and external reviews clearly do exist. Where these conditions exist, risk-management techniques such as those discussed in this chapter can be used to strengthen controls.

Table 3.1 shows the number of exchanges and clearance and settlement organizations at which we discussed each of the automation risks, along with the percentage that are implementing risk-management techniques to manage that risk.

---

<sup>1</sup>GAO/IMTEC-91-21, Apr. 2, 1991.

**Table 3.1: Risk Management Techniques  
 Used by Organizations**

<b>Risk management technique</b>	<b>Number discussed</b>	<b>Percentage using technique</b>
Security controls		
Written security plans	42	43
Risk assessments	40	70
Capacity planning		
Written capacity plans	46	46
Contingency arrangements		
Written contingency plans	46	63
Off-site backup	41	39
Independent reviews		
Security and contingency	41	66
Capacity	42	29

## Security Controls Can Prevent Intrusions

Effective security controls can ensure that automated systems are protected from misuse. Without such controls, systems are unnecessarily vulnerable to fraud, destruction of data, disclosure of restricted data, and disruption of operations. One exchange, for instance, was forced to halt trading in July 1990 when its visitors' gallery was bombed.

Officials of most of the organizations in our review generally agree that effective security controls over automated systems are needed, and said that management attention has been given to addressing physical and data security risks.

Officials related a variety of steps that they had taken to control access to automated systems (armed security guards, password-coded identification cards, and video surveillance cameras) and to safeguard the security of data in such systems (internal electronic data processing audits, system access passwords, and antivirus software packages). However, only 18 of the 42 organizations whose officials were interviewed had written security plans that mandate specific controls to ensure protection against those who could misuse their systems. Further, one of the 24 without a written security plan had just started to consider its security needs; one of its officials believes that it still lacks the needed controls. He said the exchange lacks a security plan and adequate internal control procedures over physical access, software development, and systems operations.

Twenty-eight of 40 organizations perform assessments of their automated systems to identify security weaknesses, according to their officials. For example, Cedel—an international clearance and settlement organization—regularly conducts assessments as part of its overall security process. Internally, this function is performed by a team of auditors specializing in system auditing. Annual reviews are also conducted by external auditors. Management reviews each weakness or vulnerability found, and decides whether to take corrective action or assume the risk. In contrast, 11 organizations do not conduct such assessments on a routine basis.

## Capacity Planning Can Ensure Adequate Processing Resources

Timely and efficient market operation depends on the capacity of automated systems to handle the high volumes that can be experienced. Inadequate processing resources can heighten the risk of order execution delays or failed trades, potentially worsening a market crisis.

During the October 1987 market crash, inadequate processing resources and system design problems led to order execution delays, thereby contributing to market disorder. As we reported in January 1988, these problems resulted in individuals having to make quick decisions in an atmosphere of extreme uncertainty.<sup>2</sup> This added to the confusion and panic in the markets. For instance, the New York Stock Exchange experienced an unanticipated and unprecedented volume of trades on its automated systems, and experienced problems in routing buy and sell orders and trade execution reports because some of its critical automated systems encountered volumes in excess of their capacities. Although other critical systems were capable of handling this unanticipated trading volume, which allowed the exchange to continue to operate, the systems' problems encountered affected not only the timely and efficient trading of stocks at the exchange, but also the ability of other financial markets to trade securities and associated products. The Midwest Stock Exchange also experienced transaction volumes that exceeded system capabilities, resulting in delayed orders executed at prices that were significantly different from the market price at the time the orders were received. Both of these exchanges have made improvements to increase the capacity of their automated systems.<sup>3</sup>

<sup>2</sup>Financial Markets: Preliminary Observations on the October 1987 Crash (GAO/GGD-88-38, Jan. 26, 1988).

<sup>3</sup>GAO/IMTEC-91-37, May 10, 1991.

Automated systems at a foreign exchange were not able to handle the high trading volume during the October 1989 market surge, causing officials there to institute a phased opening. However, order execution delays of several hours still occurred, and another exchange could not therefore begin to trade some related products.

Officials of the organizations interviewed are generally concerned with the capacity of their automated systems; many said they have made significant improvements to increase the capacity of their systems since the October 1987 crash. However, capacity planning efforts vary. Officials of only 21 of the organizations prepare formal plans addressing the capacity of their automated systems. The remaining 25, although lacking formal plans, said they perform capacity planning on an informal basis or considered it at the time the systems were developed.

Officials at the Depository Trust Company said that their capacity planning process includes (1) reviews of daily, weekly, monthly, and annual resource utilization and market data; (2) modeling tools and mathematical approaches to estimate future processing and storage requirements; and (3) quarterly recommendations to management on capacity planning. In contrast, officials at an exchange said they perform capacity planning only 1 year into the future. An exchange official described this process as little more than a fire-fighting effort. Another exchange had no current capacity planning process. Officials said the exchange and the system manufacturer initially developed capacity estimates for the system years earlier, but they had not made any further attempts to project future volumes because current volumes are below the system's designed capacity.

---

## Contingency Arrangements Can Ensure Timely Recovery of Operations

The assurance of continuous service in the event of equipment or software failure or natural disaster becomes increasingly critical as global markets use more automation and are increasingly interdependent. For example, an August 1990 fire at an electrical power station in New York City caused a widespread and extended power outage that in turn caused one exchange to cease operations and disrupted operations at another exchange and at numerous broker-dealer firms. The exchange that had to cease operations did not have a backup power supply. The risk of such a failure has made it essential that exchanges and clearance and settlement organizations establish contingency plans and backup capabilities to effectively recover from a variety of scenarios that could interrupt operations. If key systems or services fail, the lack of adequate contingency plans and backup capabilities could lead to individual

market disruption or even the uncoupling of the international marketplace.

Written contingency plans and procedures exist at 29 of the organizations visited, according to officials. For example, the Australian Stock Exchange has (1) disaster recovery plans and procedures for its various systems; (2) off-site backup processing capabilities for all systems; (3) a variety of communications media and systems, including leased public lines, private microwave transmitters, and alternate satellite capacity; (4) reserve power generators at all three of its computer centers; and (5) backup tapes of data, which are made daily—sometimes hourly. Plans are tested regularly to ensure that staff are familiar with the procedures under all circumstances. In contrast, 17 organizations do not have written contingency plans.

We also found that 25 organizations that have contingency procedures lacked off-site backup facilities. Officials of these organizations said their contingency plans are designed to respond only to partial—not total—trading floor and computer system outages. For example, one clearance and settlement organization does not maintain off-site backup capabilities for continuing operations if its primary facility is destroyed or damaged. Instead, its contingency plan is limited to switching from the primary central processing unit to another unit located in the same building. The organization has deliberated for years about whether it should establish a backup site in another location, but does not consider establishing an off-site backup a high priority, given its existing contingency procedures.

## Independent Reviews Can Identify Weaknesses

Exchanges and clearance and settlement organizations can obtain objective evaluations of their market systems by having independent reviews performed regularly (e.g., annually).<sup>4</sup> These reviews should address the automation risks associated with such areas as security, capacity, and contingency planning. Without this kind of review, the risk is increased that inadequate system controls may not be identified in a timely manner, or objectively reported.

The frequency and scope of independent reviews to evaluate these areas vary among the organizations visited. For example, 14 organizations

<sup>4</sup>Financial Markets: Tighter Computer Security Needed (GAO/IMTEC-90-15, Jan. 5, 1990), and Securities Industries: Additional Testing Needed to Ensure Efficient Post-Trade Processing of Stocks (GAO/IMTEC-90-83, Sept. 26, 1990).

---

**Chapter 3  
Controls Over Automation Risks Can  
Be Strengthened**

---

conduct regular independent reviews of their security and contingency planning, while 13 others only conduct such reviews on an as-needed basis—such as when new systems are developed or when major modifications to systems are made. Further, only 12 of the 42 organizations have ever undergone independent reviews of their capacity planning.

# Regulatory Oversight of Market Automation Is Limited

Market regulators have different regulatory structures, but all rely on the exchanges and clearance and settlement organizations to control automation risks. Countries with one or more national regulators over their securities and futures markets include Australia, France, Hong Kong, Japan, the Netherlands, Singapore, the United Kingdom, and the United States. Canada, Germany, and Switzerland have no such regulators; they rely instead on regional regulators to license securities and futures markets to operate.

In the United States, SEC and CFTC—the two national regulators responsible for overseeing securities and futures trading, respectively—have initiated actions to address automation risks. However, they do not regulate the trading of all financial products. Most foreign regulators have not taken steps to address automation risks but instead rely primarily on exchanges and clearance and settlement organizations to oversee automation risks, and have not issued additional policy guidance covering such risks.

## U.S. Regulators Are Working to Control Automation Risks

In the United States, SEC and CFTC have statutory responsibility to ensure the fair and equitable treatment of securities and futures market participants. Both have taken steps to oversee the risks associated with market automation.

In 1989 and 1991, SEC issued automation review policies to address automation risks. Its 1989 policy encourages securities exchanges to (1) routinely assess the security of their automated systems to control against external and internal threats, (2) establish comprehensive planning and assessment programs to test systems capacity, (3) formulate contingency plans to recover from system failures or loss of data, and (4) arrange for independent reviews of their automated systems. The May 1991 policy sets forth the nature of the independent reviews that securities exchanges are encouraged to obtain with respect to their automated trading and information dissemination systems. The new policy also specifies the contents of annual reports required of securities exchanges on major system changes, and lays out a process for providing notifications to SEC of material system changes. Finally, the 1991 policy sets forth requirements for notification to SEC of significant system outages and other problems experienced by securities exchanges.

CFTC, for its part, is defining the review roles of the self-regulatory organizations (futures exchanges), independent reviewers, and the Commission. It has also (1) evaluated automated systems as part of its rule-

enforcement reviews; (2) established a federal interagency task force to help it design a program for overseeing automated market systems; (3) taken steps to develop a formal policy for automated system assessments; (4) issued guidance requiring self-regulatory organizations to retain documentation regarding the development, implementation, and operation of automated systems; (5) performed reviews of planned automated systems; and (6) adopted ten general principles to help regulators review screen-based trading systems (these principles were developed by a working group of the International Organization of Securities Commissions that was chaired by CFTC).

## **Foreign Regulators' Involvement in Addressing Automation Risks Is Limited**

Foreign regulators we interviewed rely heavily on their market organizations to control automation risks. Some regulators said they lack the technical expertise to assess the actions of the exchanges and clearance and settlement organizations. None of the foreign regulators visited has performed an on-site technical examination or issued policies, standards, or regulations pertaining to automation risks.

Many regulators discuss automation risks at meetings with their market organizations. Some discuss or review capacity, security, and contingency issues when they meet with market organizations to plan a system or when they review revisions to exchange rules. For example:

- One regulator receives briefings on an ongoing basis from its exchanges and comments on the automated systems being used. The regulator also discusses automated systems issues during its process of approving exchange rules. However, these discussions have been at a general—not technical—level. In one instance regulatory officials recommended that an exchange follow computer security standards issued by another government agency when the exchange was designing its processing center.
- Officials of another regulator routinely collect and analyze systems information that exchanges provide voluntarily. This information includes security, access controls, and trade monitoring for automated systems operated by the exchanges.
- Officials of a third regulator rely on discussions with its market organizations to see that automation risks are addressed. For example, this regulator recommended that a clearance and settlement organization identify existing automation standards for use in developing its automated clearance system. Officials plan to examine security, capacity, and contingency risks throughout their market at a later time.

# International Forums and Their Role in Automation Issues

International organizations are working to improve the operation of securities and futures markets and are proposing various approaches to enhancing market development. We identified six international organizations that have addressed aspects of automation, but none is focusing its attention on automation risks. Although views differ on the need for an international forum to discuss this issue, a number of existing organizations were cited by regulator, exchange, and clearance and settlement officials as potential forums for addressing the risks posed by automation.

---

## International Groups Addressing Automation Issues

The following six international organizations are addressing the operation of financial markets, including some aspects of automation:

- Fédération Internationale des Bourses de Valeurs (FIBV),
- Group of Thirty (G-30),
- International Organization for Standardization (ISO),
- International Organization of Securities Commissions (IOSCO),
- International Society of Securities Administrators (ISSA), and
- Organization for Economic Cooperation and Development (OECD).

---

## The Fédération Internationale des Bourses de Valeurs

FIBV encourages the sharing of information among stock exchanges. Also known as the International Federation of Stock Exchanges, this body includes members from 36 stock exchanges around the world. Recent FIBV studies have focused on improving international clearance and settlement, and disclosure requirements. At its October 1990 Markets and Technology Workshop, FIBV (1) reviewed the progress of electronic trading aids; (2) discussed how technical, political, marketing, timing, competitive, and regulatory factors affect the success of new trading systems, information systems, and settlement systems; and (3) examined case studies of market links to determine what business factors create success or failure.

According to FIBV's Secretary General, while controlling the risks associated with automating securities markets is important, individual securities markets already adequately address such risks.

---

## Group of Thirty

G-30 is an independent, nonprofit organization that studies broad financial issues, such as balance of payments, Third World debt, and global securities markets. It consists of 30 members representing international bankers, other international businesses, and academia.

In March 1989, G-30 issued a report addressing deficiencies in the clearance and settlement of securities transactions, and the risks associated with these deficiencies.<sup>1</sup> It reported that many of the deficiencies also adversely affect automated global links and individual systems. To address these problems, G-30 developed nine recommendations, which essentially propose standards for clearance and settlement, to be followed by national markets. These recommendations involve such practices as (1) accomplishing securities trade comparisons within 1 day and final settlement of trades on the third business day after the trade, and (2) adopting two technical standards developed by ISO (see below) for securities messages and a common securities numbering system for international trades. In March 1990, G-30 met to discuss worldwide progress toward implementing its recommendations. Although participating countries had different systems in place and faced different constraints, individual country status reports indicated that most were working toward implementing the recommendations. Officials from all countries in our review said they were taking steps to implement the G-30 recommendations.

---

### International Organization for Standardization

ISO brings together practitioners from a wide range of industries to develop standards through consensus of participants in the industry to which the standards apply. ISO is the international equivalent of the American National Standards Institute in the United States, which approves various standards, including many dealing with automation.

Although they have not addressed processing or systemic risks associated with automation, an ISO subcommittee on securities has issued standards defining the International Securities Identification Number (ISIN) system, and message standards for communication between banks. These standards are intended to reduce automation risks by eliminating potential misunderstandings, as well as easing the implementation of automated cross-border systems by standardizing key elements of the interface between systems. The subcommittee chairman said that reducing automation risks is important to ISO, and setting international standards for use in automated systems is one way of reducing such risks. Further, he noted that the subcommittee is also working to develop standards for (1) messages among securities depositories, (2) messages between securities depositories and banks, and (3) codes for types of securities.

---

<sup>1</sup>Clearance and Settlement Systems in the World's Securities Markets, Group of Thirty, New York and London, March 1989.

---

## International Organization of Securities Commissions

IOSCO plays an ongoing role in the development of international securities and futures markets. Its membership of about 80 representatives includes regulators from more than 50 countries, securities and futures exchanges, clearance and settlement organizations, and other international groups. IOSCO brings together these various representatives to ensure the efficiency and integrity of securities and futures markets. In 1987 it created a technical committee to examine issues—such as globalization—faced by major markets.

During its 1988 annual conference IOSCO addressed lessons learned from the 1987 market crash, including the need for standards for computer-based processing of securities trading, clearance, and settlement. Its technical committee identified areas of priority concern and set up individual working groups for each area. One of the groups, chaired by CFTC, reported on the regulatory implications of screen-based trading systems of derivative products. The report set out ten principles to be followed; several involved the automation issues of security, capacity, and risk assessment. For example, the following two principles were included in the report.

“From a technical perspective, the system should be designed to operate in a manner which is equitable to all market participants, and any differences in treatment among classes of participants should be identified.

Before implementation, and on a periodic basis thereafter, the system and system interfaces should be subject to an objective risk assessment to identify vulnerabilities (e.g., the risk of unauthorized access, internal failures, human errors, attacks, and natural catastrophes) which may exist in the system design, development, or implementation.”

The report was presented to the entire membership at its 1990 meeting. Because IOSCO is not an enforcer of international rules or regulations, a resolution was proposed and passed by the membership to adopt and implement the ten principles in the member countries' futures markets. IOSCO plans to report on the progress of member country adoption of these principles at its 1991 meeting.

IOSCO plans to follow up on the above-mentioned screen-based-trading principles and to develop issues affecting fully automated cross-border securities trading systems. During its 1990 annual conference, IOSCO's technical committee elected a chairman and restructured all its working groups into four new working groups. Each is chaired by a senior staff person from a major securities regulator. Two of these groups currently

deal with specific issues related to automation. IOSCO's Secretary General believes that IOSCO is an appropriate international vehicle for discussion, elaboration, and eventual implementation of practical solutions to major automation issues. This is because of its large and diverse membership of regulators, exchanges, and other organizations with a mission related to the regulation or development of securities markets.

---

**International Society of  
Securities Administrators**

ISSA is sponsored by six international banks and one international securities house, and has approximately 100 participating members, such as banks, brokers, and stock exchanges, from 30 countries. It serves as a forum for information exchange and a resource organization for those involved in custody services and clearance and settlement. It performs research on the status of international clearance and settlement, and shares its results through publications, newsletters, international symposia, and a handbook that describes the regulatory regimes, securities markets, and settlement mechanisms for 30 major securities markets.

The Secretariat of ISSA sees automation as playing a key role in how international securities markets function. According to ISSA, computer technology is no longer simply an aid, but an indispensable means for conducting securities business. Two of ISSA's three working groups are studying automated cross-border trade matching and settlement issues.

---

**Organization for Economic  
Cooperation and  
Development**

With representation from 24 countries, OECD's goals are to achieve high economic growth, contribute to sound economic expansion, and encourage the free flow of goods, services, and capital. OECD has traditionally looked at securities markets in terms of their contribution to international capital flows and the functioning of the financial system at large.

However, in recent years OECD has taken a more active role in addressing other areas. For example, an OECD official presented a paper to the annual IOSCO conference in September 1989 on market automation and its implications for regulatory activity. This paper suggested that government regulatory bodies will, at some point, have to address the implications of increased automation in securities markets. It also pointed out that markets have placed reliance on competition as the major tool used for improving efficiency and automation risks. However, competition and efficiency are not identical objectives. Consequently, the need for

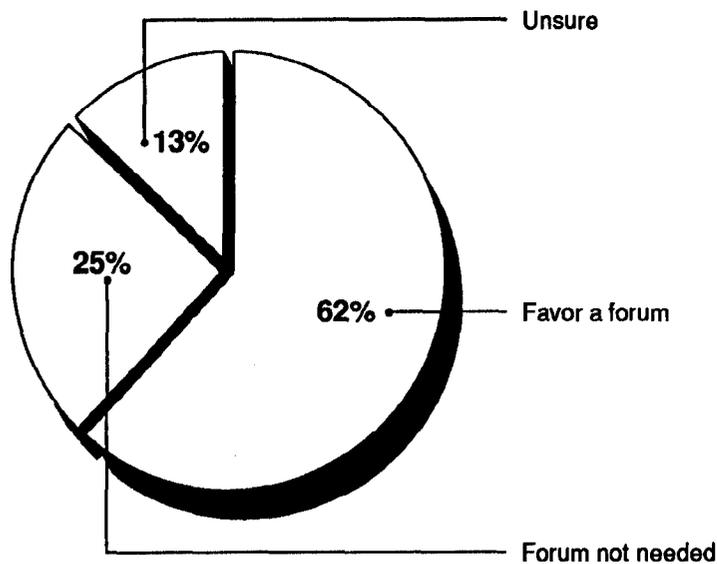
cooperation in developing the technological infrastructure of the financial systems may be a better approach to dealing with efficiency questions than reliance on competition to control system risks.

We were also told that OECD is developing a paper on automation of the securities markets, which it plans to publish in late 1991.

## Most Support a Forum on Automation Risks

We obtained information from representatives of 52 of the 61 regulators, exchanges, and clearance and settlement organizations visited. Of the 52, most said they favor using forums to address the risks associated with automation. Although various organizations were suggested for such forums, the three suggested most often were IOSCO, G-30, and FIBV. Some officials said that a formal organization is not needed in today's market environment, though it might become necessary in the future. Figure 5.1 shows that almost two-thirds of the 52 representatives believe a need exists for an international forum to address automation risks.

Figure 5.1: Market Representatives' Positions on Whether an International Forum Is Needed to Address Automation Risks



We also obtained the views of senior officials of the two U.S. regulators. Officials of SEC's Division of Market Regulation suggested that IOSCO

---

**Chapter 5**  
**International Forums and Their Role in**  
**Automation Issues**

---

would be a good forum for addressing automation risks, while CFTC officials suggested that using various international forums could be beneficial. We agree that one or more forums could help better address and reduce the risks associated with intermarket automation.

# Conclusions and Recommendations

Automation is bringing the world closer together: it is increasingly relied upon by the financial community, but it also introduces new market risks and the potential for market disruption and uncertainty. How these risks are minimized can determine the degree of confidence that investors will place in the financial marketplace—and perhaps the degree to which such confidence is deserved.

Market officials say they are aware of automation risks, but methods and degrees of addressing such risks vary widely. Oversight is likewise limited and uneven; indeed, the roles of national regulators vary considerably in the countries that even have such a position. However, the critical nature of these automated systems argues for markets around the world to coordinate their efforts to ensure that they give sufficient attention to automation risks. Risk-management techniques can be used to assure secure and continuous service, correct processing of transactions, and responsive operations. We believe it is more important to anticipate and eliminate potential problems as we approach the next century, rather than to wait for them to materialize. Cooperation among markets could help to address these problems.

## Recommendations

In order to foster dialogue in world financial circles and shape policies that can effectively deal with the risks associated with automation, we recommend that the Chairmen of the U.S. regulatory bodies—the Securities and Exchange Commission and the Commodity Futures Trading Commission—actively identify and take advantage of opportunities to address automation risks with the international financial community. This could be accomplished through existing organizations such as IOSCO, G-30, and FIBV, to

- create an international forum to discuss and debate automation issues and risks;
- frame the global issues that should be addressed, to ensure that such areas as security, capacity, contingency planning, and independent technical reviews are addressed; and
- develop global principles and risk-management techniques to address automation risks and actively work with international markets to gain their acceptance and use.

## Agency Comments

In commenting on a draft of the report, senior officials of CFTC and of SEC's Division of Market Regulation generally agreed with the report's

conclusions and recommendations. We have incorporated their comments in the report as appropriate. SEC officials said that their comments did not necessarily represent the Commission's views, but that such views will be provided after the final report is issued and reviewed. Although CFTC and SEC do not have authority over the activities of foreign markets, both were asked to comment on the draft report because the recommendations were directed to them.

The accuracy and completeness of information in this report covering the activities and practices of other U.S. and foreign entities were confirmed with officials of those entities during the course of GAO's work. These entities were not, however, asked to review and comment on a draft of the report. Instead, specific information reported on individual exchanges, clearance and settlement organizations, and international organizations was reviewed and confirmed by officials representing such entities.

# Objectives, Scope, and Methodology

We initiated this review in anticipation of increased congressional interest in the use of automation in international financial markets. Our objectives were to identify (1) the automated systems and electronic links being used and planned by exchanges, clearance and settlement organizations, and broker-dealer firms in these markets; (2) the steps markets are taking to address the risks of using automation; (3) the extent of regulatory oversight of automation issues provided by financial market regulators; and (4) the automation issues being addressed by international organizations. Specifically, we documented the extent of automation being used in the market structures of order routing and execution, information dissemination, and clearance and settlement.

We met with representatives of 32 securities and futures exchanges; 17 clearance and settlement organizations; 6 information dissemination companies; 28 broker-dealer firms; 10 national and 2 state-level regulators; and 6 international organizations representing the securities and futures industry. These representatives were located in Australia, Belgium, Canada, France, Germany, Hong Kong, Japan, Luxembourg, the Netherlands, Singapore, Switzerland, the United Kingdom, and the United States. A complete list of all organizations visited is contained in appendix II.

To document the extent to which financial markets were using automated systems and electronic links, we interviewed officials from all the exchanges, clearance and settlement organizations, and information dissemination companies to understand how they use automation and links with other markets. We also obtained, when available, descriptions and diagrams of the automated systems. We interviewed officials from selected broker-dealer firms operating in most of the countries to find out how they use automated systems and what their opinions are on the need for links between markets.

We interviewed officials from 30 exchanges, 16 clearance and settlement organizations, and 11 regulators to obtain their views on the importance and significance of automation risks. We reviewed and obtained available supporting documentation regarding the following automation issues: (1) planning for sufficient system resources to handle expected transaction volume increases; (2) assuring the security of systems against intrusions; (3) planning for contingencies; (4) performing independent technical reviews of systems; and (5) developing international forums to discuss global automation issues. In discussing organizations' data processing operations and their practices to control risks, we relied

primarily on the testimonial evidence presented and did not independently verify or assess the quality or appropriateness of the individual controls in place at each organization. In a limited number of instances, we were unable to discuss all of the automation issues with each organization because of time constraints and the unavailability of officials.

To identify the extent of regulatory oversight of automation, we interviewed ten national and two regional regulatory officials on their involvement with the automated systems of the exchanges and clearance and settlement organizations. In addition, we obtained and reviewed any regulations, policies, studies, or documents these regulatory bodies prepared concerning automation.

To ascertain the need for international organizations to hold forums on automation issues, we interviewed officials from the exchanges, clearance and settlement organizations, and regulatory bodies concerning the organizations they believed were most appropriate to perform this function. We also met with officials of six international organizations concerned with the operation of securities and futures markets to identify their involvement with automation issues and to learn about their organizations' objectives and membership.

---

# Organizations Visited During Review

---

## Australia

Regulator

Australian Securities Commission (formerly the National Companies and Securities Commission)

Exchanges

Australian Options Market

Australian Stock Exchange

Sydney Futures Exchange

Clearance and Settlement Organization

International Commodities Clearing House

Other

Reserve Bank of Australia

---

## Belgium

Clearance and Settlement Organization

Euroclear

Other

Federation of Stock Exchanges in the European Community

---

## Canada

Regulators

Ontario Securities Commission

Quebec Securities Commission

Exchange

Toronto Stock Exchange

Clearance and Settlement Organization

Canadian Depository for Securities, Limited

Other

International Organization of Securities Commissions (IOSCO)

---

## France

Regulator

Commission des Opérations de Bourse

Exchanges

Société des Bourses Françaises

Marche à Terme International de France (MATIF)

---

**Appendix II**  
**Organizations Visited During Review**

---

Clearance and Settlement Organization

Société Interprofessionnelle pour la Compensation des Valeurs Mobilières  
(SICOVAM)

Broker-Dealer

Merrill Lynch Capital Markets (France)

Others

Organization for Economic Cooperation and Development (OECD)  
The Fédération Internationale des Bourses de Valeurs (FIBV)<sup>1</sup>

---

**Germany**

Exchange

Deutsche Terminbörse GmbH

Clearance and Settlement Organization

Deutscher Kassenverein AG

Broker-Dealers

Credit Suisse First Boston  
Morgan Stanley GmbH  
Salomon Brothers AG

Others

Andersen Consulting  
Dr. Jörg-Ronald Kessler (consultant)

---

**Hong Kong**

Regulator

Securities and Futures Commission

Exchanges

Hong Kong Futures Exchange<sup>2</sup>  
Stock Exchange of Hong Kong<sup>3</sup>

---

<sup>1</sup>Organization is headquartered in France; however, we interviewed its Secretary General in Amsterdam, the Netherlands.

<sup>2</sup>Automation risks were not discussed with officials of this exchange.

<sup>3</sup>Currently, clearance and settlement is performed by the exchange. However, the newly-created Hong Kong Securities Clearing Corporation will assume the exchange's clearance and settlement functions when it becomes operational.

---

Clearance and Settlement Organization  
International Commodities Clearing House—Hong Kong

Broker-Dealers  
Citicorp Scrimgeour Vickers—Hong Kong  
Morgan Stanley Asia

---

Japan

Regulator  
Ministry of Finance

Exchanges  
Osaka Securities Exchange  
Tokyo Commodity Exchange  
Tokyo International Financial Futures Exchange  
Tokyo Stock Exchange

Clearance and Settlement Organization  
Japan Securities Clearing Corporation

Broker-Dealers  
Credit Suisse First Boston (Japan)  
Daiwa Securities Company  
Nomura Securities Company  
Salomon Brothers Asia

Private Information Vendor  
Quick Corporation

Others  
Futures Industry Association—Japan  
Japan Securities Dealers Association

---

Luxembourg

Clearance and Settlement Organization  
Cedel

---

The Netherlands

Regulator  
The Securities Board of the Netherlands

Exchanges

The Amsterdam Stock Exchange  
The European Options Exchange

---

Singapore

Regulator

Monetary Authority of Singapore

Exchanges

Singapore International Monetary Exchange  
Stock Exchange of Singapore

Clearance and Settlement Organization

Central Depository of Singapore

Broker-Dealers

J.M. Sassoon  
Merrill Lynch, Pierce, Fenner and Smith (Singapore)  
Shearson Lehman Hutton

Other

National Computer Board

---

Switzerland

Exchange

Association Tripartite Bourses

Clearance and Settlement Organization

Schweizerische Effekten-Giro AG

Private Information Vendor

TELEKURS AG

Others

International Organization for Standardization (ISO)  
International Society of Securities Administrators (ISSA)

---

United Kingdom

Regulators

Department of Trade and Industry  
The Securities and Investment Board

Exchanges

The London Stock Exchange (formerly the International Stock Exchange, London)  
The London Futures and Options Exchange  
The London International Financial Futures Exchange

Clearance and Settlement Organization

London Clearing House

Broker-Dealer

S.G. Warburg Securities

Others

Futures Industry Association—U.K.  
Reuters Limited

---

**United States**

Regulators

Commodity Futures Trading Commission (CFTC)  
Securities and Exchange Commission (SEC)

Exchanges

American Stock Exchange  
Boston Stock Exchange  
Chicago Board Options Exchange  
Chicago Board of Trade  
Chicago Mercantile Exchange  
Cincinnati Stock Exchange<sup>4</sup>  
Commodity Exchange, Inc.  
Midwest Stock Exchange  
National Association of Securities Dealers (NASD)  
New York Mercantile Exchange, Inc.  
New York Stock Exchange

Clearance and Settlement Organizations

Board of Trade Clearing Corporation<sup>5</sup>

---

<sup>4</sup>Automation risks were not discussed with officials of this exchange.

<sup>5</sup>Information on the automation in the clearance and settlement structure for the Board of Trade Clearing Corporation was obtained during previous reviews. Automation risks were not discussed with officials of this organization during this review.

---

**Appendix II**  
**Organizations Visited During Review**

---

Depository Trust Company  
International Securities Clearing Corporation  
Midwest Securities Clearing Corporation  
National Securities Clearing Corporation  
Options Clearing Corporation

Broker-Dealers

Cowen & Company  
Daiwa Securities America, Inc.  
Dillon, Read & Co., Inc.  
Deutsche Bank Capital Corp.  
Ferris & Co., Inc.  
First Boston, Inc.  
Johnston, Lemon & Co., Inc.  
Merrill Lynch & Co., Inc.  
Morgan Stanley Group, Inc.  
Nomura Securities International, Inc.  
Quick & Reilly Group, Inc.  
Salomon Brothers, Inc.  
Spear, Leeds & Kellogg  
S.G. Warburg

Private Information Vendors

Automatic Data Processing, Inc.  
Knight Ridder Financial Information Group  
Quotron Systems, Inc.  
Telerate, Inc.

Others

Futures Industry Association  
Group of Thirty (G-30)  
Securities Industry Association

---

# Automated International Links

---

During our review we asked that exchange officials and clearance and settlement organization officials identify and describe active, planned, and discontinued links with other exchanges and clearance and settlement organizations for the functions of order routing and execution, information dissemination, and clearance and settlement. The following are descriptions of the automated links identified by these officials.

---

## Order Routing and Execution

Boston Stock Exchange officials said they established an automated order routing link in 1984 with the Montreal Exchange. They said the link enables Montreal exchange members to electronically route orders in any stock eligible for trading on the Boston Stock Exchange. However, one of the officials said that the link has not been very active because it has been limited to Montreal Exchange members who have automated order routing capability. A Boston Stock Exchange official also said that the exchange is planning to electronically link an order routing system at the Montreal Exchange with Boston's automated order routing and execution system in late 1991 to increase the activity over the current link.

Officials at the Australian Options Market said order routing links have been established between the Australian Options Market, the Montreal and Vancouver (Canada) stock exchanges, and the European Options Exchange in the Netherlands for trading precious metals options. They said that the link involved passing orders electronically among the markets at their respective closings, to be filled in the next market. However, officials said that this link was discontinued in February 1991 because the market in precious metals options failed to develop to the extent required to justify the cost of operating it.

Representatives of the American Stock Exchange and the Toronto Stock Exchange said that they operated an automated trading link from about September 1985 to October 1988. They said that when the link was in operation, members of each exchange were able to trade selected Canadian stocks on either exchange. However, officials of both exchanges said that the link was discontinued.

---

## Information Dissemination

According to one of its officials, the National Association of Securities Dealers (NASD) has several information dissemination links to other exchanges. The association established a communications link with the London Stock Exchange in 1986, to provide quote information on 350 NASD stocks to brokers, dealers, and institutional investors in the United

Kingdom. At the same time, firms using NASD terminals in the United States receive current quotations on 350 London-quoted stocks. NASD officials also said that they established a communications link in 1988 with the Stock Exchange of Singapore to provide a daily exchange of quotes on 35 of their securities that are also traded on the Singapore exchange. In addition, NASD officials said they are planning to extend their automated quotation system link with the London Stock Exchange to others in the United Kingdom by using a London communications link.

An official of the Federation of European Stock Exchanges said the federation, with the assistance of representatives from French exchanges, is developing a system. This system would enable all stock exchanges of the European Community to quote simultaneously some 200 mainly European securities, which could be traded at any of these stock exchanges.

---

## Clearance and Settlement

A Midwest Clearing Corporation official said that the corporation has links with the London Stock Exchange and the Canadian clearing and depository in Vancouver to provide for the settlement of international transactions between U.S. brokers and institutions and members of these foreign entities, as well as safekeeping of securities involved in such transactions.

According to officials at the Options Clearing Corporation, they have a clearance link with the European Options Exchange for clearing a single-options contract of the American Stock Exchange.

Representatives of Cedel and Euroclear, international clearance and settlement organizations, said they have developed clearance links with major markets around the world. While these links are available for many debt and money market issues, officials said that the settlement of equities is available on a smaller scale.

An Amsterdam Stock Exchange official said that the exchange clears and settles securities of ten foreign countries traded in Amsterdam, using links to foreign-country depositories.

Officials of the Singapore International Monetary Exchange said they have a link with the Chicago Mercantile Exchange for clearing the trading of selected futures contracts.

According to an official of the Tokyo Stock Exchange, it has links through its clearing organization—the Japan Securities Clearing Corporation—for custody service of certain securities with clearance organizations or depositories in Canada, France, Germany, the United Kingdom, and the United States to facilitate the clearance and settlement of trades of these countries' stocks listed on the Tokyo Stock Exchange. The official said that the Tokyo Stock Exchange also has links through the clearing corporation for custody service of certain securities with clearance organizations or depositories in France, the Netherlands, and Singapore, for clearing the trades of Japanese securities listed on those countries' exchanges.

An official of the Canadian Depository for Securities said that the depository has a clearing link with the National Securities Clearing Corporation. It also operates a ledger account for the Japan Securities Clearing Corporation. The official said that this is an in-bound link in which the Japanese clearance organization holds positions in Canadian securities at the Canadian Depository for Securities.

International Securities Clearing Corporation officials said that the corporation has a number of links with central clearance and depository organizations in major market centers. They said that the corporation has developed a bilateral clearance and settlement link with the London Stock Exchange. They also said they have links with the Japan Securities Clearing Corporation and the Central Depository (Pte.) Ltd. of Singapore for U.S. issues traded in their markets, and a data communication link with Cedel in Luxembourg. It is also considering developing links with France, Germany, and Switzerland.

Officials of the Sydney Futures Exchange said that their exchange had clearance links with the London International Financial Futures Exchange and with the Commodities Exchange in New York from about 1984 to 1987. However, they said that these links have been discontinued because of low transaction volume.

---

# Major Contributors to This Report

---

**Information  
Management and  
Technology Division,  
Washington, D.C.**

Leonard Baptiste, Jr., Assistant Director  
Richard J. Hillman, Assistant Director  
Norman F. Heyl, Evaluator-in-Charge  
Tamara J. Lilly, Staff Evaluator  
Ann Farabaugh, Staff Evaluator  
Michael P. Fruitman, Supervisory Reports Analyst

---

**Chicago Regional  
Office**

Alexandra Y. Martin, Senior Evaluator

---

**European Office**

Paul D. Alcocer, Senior Evaluator  
James A. Perez, Staff Evaluator

---

**Far East Office**

Glenn D. Slocum, Senior Evaluator  
Cody J. Goebel, Staff Evaluator

---

**New York Regional  
Office**

Jeffrey Shapiro, Staff Evaluator  
Judith Rose, Staff Evaluator





---

# Related GAO Product

---

An executive summary supplement to this report (GAO/IMTEC-91-62ES) is available that includes translations in French, German, Japanese, and Spanish. The first five copies are free. Additional copies are \$US 2 each. Orders specifying this report number should be sent to the address listed below, accompanied by a check or money order payable to the Superintendent of Documents. Orders for 100 or more copies to be mailed to a single address are discounted 25 percent. Orders may also be placed by calling (202) 275-6241.

Un supplément récapitulatif au présent Rapport (GAO/IMTEC-91-62ES) est disponible, avec les traductions en français, allemand, japonais et espagnol. Les cinq premiers exemplaires sont gratuits; le prix de chaque exemplaire supplémentaire est de 2 dollars des Etats-Unis. Veuillez envoyer les commandes, en spécifiant la référence ci-dessus, à l'adresse indiquée ci-dessous, avec un chèque ou un mandat à l'ordre du Superintendent of Documents. Les commandes d'au moins 100 exemplaires à expédier à la même adresse bénéficieront d'une remise de 25 pour cent. Les commandes peuvent aussi être faites par téléphone, en appelant le (202) 275-6241.

Eine zusammenfassende Beilage zu diesem Bericht (GAO/IMTEC-91-62ES) mit Übersetzungen in die französische, deutsche, japanische und spanische Sprache kann geliefert werden. Die ersten fünf Kopien sind kostenlos. Weitere Kopien kosten je US\$ 2,00. Bestellungen mit Angabe der Berichtsnummer sind an die nachstehende Adresse zu richten zusammen mit einem Scheck oder einer Geldanweisung ausgestellt auf den Superintendent of Documents. Für Bestellungen von 100 oder mehr Kopien an ein und dieselbe Adresse wird ein Rabatt von 25 Prozent gewährt. Bestellungen können auch telefonisch über die Nummer (202) 275-6241 aufgegeben werden.

本報告書 (GAO/IMTEC-91-62-ES) の概略報告書 (付録) が、フランス語、ドイツ語、日本語、及びスペイン語で用意されています。最初の5冊は無料で提供されますが、それ以上の数になりますと2ドル/冊です。本報告書 (付録) をご購入の際には、報告書の番号を指定し、小切手またはマネー・オーダー (宛先: Superintendent of Documents) を下記の住所まで郵送して下さい。100冊以上のご注文に対しては25%の割引が適用されます。電話によるご注文も可能です。(電話: 202-275-6241)

Del presente informa se publica un suplemento (GAO/IMTEC-91-62ES), en calidad de resumen, con traducciones al alemán, español, francés y japonés. Los primeros cinco ejemplares son gratuitos. Cada ejemplar adicional cuesta US\$ 2. Los pedidos, en los que debe constar dicho número de informe, se enviarán a la dirección que aparece posteriormente, acompañados de cheque o giro postal pagadero al Superintendent of Documents. Los pedidos de 100 o más ejemplares para una misma dirección se descuentan en un 25 por ciento. Los pedidos también se pueden hacer por teléfono al número (202) 275-6241.

**U.S. General Accounting Office  
P.O. Box 6015  
Gaithersburg, MD 20877**

---

### **Ordering Information**

**The first five copies of each GAO report are free. Additional copies are \$2 each. Orders should be sent to the following address, accompanied by a check or money order made out to the Superintendent of Documents, when necessary. Orders for 100 or more copies to be mailed to a single address are discounted 25 percent.**

**U.S. General Accounting Office  
P.O. Box 6015  
Gaithersburg, MD 20877**

**Orders may also be placed by calling (202) 275-6241.**

**United States  
General Accounting Office  
Washington, D.C. 20548**

**Official Business  
Penalty for Private Use \$300**

**First-Class Mail  
Postage & Fees Paid  
GAO  
Permit No. G100**