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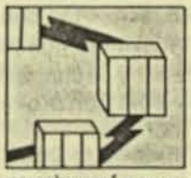
Solving the problems of distributed databases

True distributed databases—where dispersed records look to users as one unit, without centralized control—are now appearing. Here's how it is done.



Despite the increasing number of computers within many companies today, the full value of all this hardware—the potential return on investment—is often not realized because the diverse computing resources cannot share information. However, recent advances in the area of distributed databases (DDBs) are now making it possible for all corporate data to be accessible through a single resource.

Such schemes permit companies that have even widely dispersed data repositories to retain the advantages of locally controlled data. A true distributed database represents a decentralized scheme for data management wherein files are spread through a collection of autonomous nodes that communicate with one another via a common language. The purpose of such a decentralized database is to make all the data that is available to the corporation as a whole also conveniently available to individual users. This data availability can, for example, facilitate the local management of day-to-day tasks while also providing a basis at the corporate level for planning future strategies.

Though the nodes in a distributed database can exist in one room or building, these nodes are usually geographically separated. The DDB can therefore link a worldwide corporation into a single operating entity, with vital information available in a timely fashion wherever it is needed (Fig. 1). With a properly implemented distributed database, critical data can be stored, updated, and retrieved, independent of the location of either the data or the user.

The term "distributed" database has been used to describe some data management schemes that really offer only a subset of true distributed database capabilities. One example is a centralized database that is accessible from remote nodes. This can more precisely be called a shared database, which provides, in reality, only distributed access to centralized data. Another scheme features individual databases residing on computers that are linked in a network. While these are, in a literal sense, "distributed" databases, the data within each is still inherently centralized.

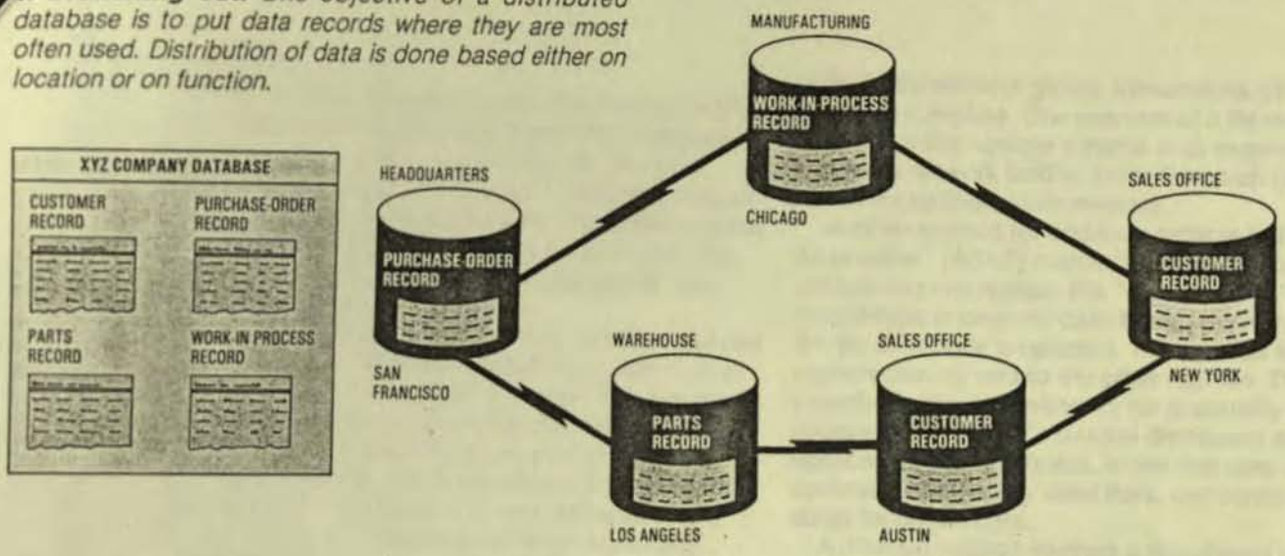
There are several technical considerations that make a truly distributed data management scheme attractive—the main one being the sheer size of many databases today. Linking diverse data files into a single resource often provides additional capacity that is increasingly hard to find with the single, centralized approach. A decentralized data management "network" could consist of literally hundreds of individual processors located around the world, with the data in each available to every node.

Only the data that is used on a daily basis need be kept at a local node; other useful information in the database is accessible remotely. In this way, data availability can be guaranteed by placing critical data at the local node. Naturally, placing data next to its most frequent users speeds response time in retrieving this data.

The autonomy of nodes in a distributed database allows each organizational entity to manage its information in its own way. And since each node is independent, and the data location transparent to the user community, the database configuration is modular and, therefore, flexible. Network nodes can be added, deleted, and rearranged without significantly affecting data access and usage.

From a management standpoint, linking data into a single resource provides a way to track the status of the corporation as a whole with convenient access to network-wide data. At the same time, control of local data resources can be kept at the divisional or depart-

*1. **Branching out.** One objective of a distributed database is to put data records where they are most often used. Distribution of data is done based either on location or on function.*



mental level. The existence of a corporate-wide database need not impact the efficiency of local data management and retrieval activity.

Another big plus to management is the flexibility provided by a decentralized data management scheme. The data distribution can be designed to reflect the changing needs of a business: When information needs change, the database can too.

Distribution design

Several non-issues with a centralized database, such as how the data will be distributed, become critically important in a decentralized environment. There are two main approaches to distributing data: Decentralize by function, or decentralize by location.

The selection of the best decentralization method is based on the particular application, or the way data will be used. If the data will typically be accessed repeatedly by the same users, then decentralization by function could be the more appropriate. Examples of this would be putting manufacturing materials lists at the appropriate manufacturing plants and customer information at sales locations.

Partitioning customer information on a node-per-region basis is an example of decentralizing by location. This method might be used for data pertaining specifically to a sales region or other geographically based entity within the corporation.

Another key issue that has to be resolved in evaluating the feasibility of a distributed database is the degree of decentralization. For example, function and maintenance of individual nodes can be decentralized while the operation and control of the collective database and network remains centralized. Or it may be preferable, depending on the situation, to further decentralize operation and control while keeping the design of the database and network architecture centralized. At the extreme, it may be desirable to decentralize everything, except the "global protocol" architecture.

An analogous example of maximum decentralization is the international telephone network. Each telephone company independently implements the common protocols of the international phone network (such as for dialing and billing), and the only centralized function is the architecture of these protocols. Within each company, design and architecture are typically centralized, while operation and control are delegated to the operating regions. These regions, in turn, delegate most operation and maintenance to the individual exchanges, which operate and maintain their own local hardware.

Searches

A major challenge in designing and managing a distributed database results from the inherent lack of centralized knowledge of the entire database. It is difficult and often undesirable to maintain information concerning the entire database in any one place, but this requirement seems inevitable in order to manage requests such as, "Where is file A?"

One solution to this dilemma involves the concepts of global, local, and semiglobal data. Global data is information that is common to and shared by all sites. Examples of global data are an item master file of parts that comprise a company's parts catalog and a bill-of-materials file that describes a product's structure.

Local data is information that is uniquely important to the individual site using it, although it is accessible to all sites. Examples of local data are items in stock and work in process. Local data retains the same format as corresponding data has at other sites.

Semiglobal data is used in internodal—and often intersite—transactions. This might be the case for, say, an interplant materials transfer. In this case, a request by one site for materials from another is placed, processed, and monitored. The process requires that all data and status information pertaining to the request be resident at both sites. But since this information is of no use to any third party, it is duplicated only at the two

nodes that use it.

Information is made available to the entire network by partitioning or replicating the data files. Partitioning a data file means splitting it into records and then distributing the records so that each record resides at exactly one network node (Fig. 2A). Replication means duplicating data records at more than one node (Fig. 2B). Local data can be partitioned, but global data must be replicated.

Data is partitioned to put it close to the sites that use it. An example might be storing bank account data at the home branch of the bank customer. This has the effect of reducing message traffic and message delay, and of distributing work. In the case of an airlines reservation network, data is partitioned by corporation. Most transactions submitted by one airline deal only with that airline and therefore run on a single node. Transactions that deal with other airlines are routed to other airlines' nodes, as appropriate.

Replication also serves the purpose of bringing data closer to the user, and has long been used to improve data availability. If one copy of a file is lost, for whatever reason, another can be accessed at a remote node. Global data is replicated at all sites. In a geographically distributed database network, replication also provides the benefit of improving response time by eliminating long-haul message delays.

Updating

Partitioned data is most efficient when the data must be kept current, which generally means that it is updated frequently. The single copy of each data item makes updating an efficient process. However, nonlocal "read" operations are more expensive, making partitioning less efficient for data that is widely used but updated infrequently. In the Tandem scheme, a database record manager allows files to be partitioned among network nodes based on single field values within files, such as "part number" or "customer name."

Replicated data is most efficient when multiple reads of the data are expected, but updates are not as frequent. The data is duplicated at nodes where high-volume reads are expected, producing high availability and good response time. When replicated data must be updated, however, an update to a record at one node should cause an identical update at all other nodes where that record resides. If any one replica is unavailable, there could be problems.

A variety of schemes can be employed for updating replicated data, even though the copy of the record may be temporarily unavailable at one or more of the nodes. One technique requires that a majority of the replicas be read and updated as part of each transaction, though the definition of "majority" varies with the application. This scheme has the advantage of tolerating some nodal unavailability, but it is not practical for either very small or very large networks.

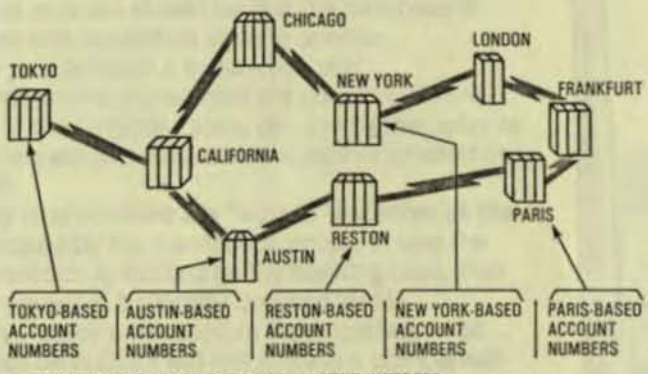
In a very small network of, say, two nodes, having either node unavailable prevents an update of a majority of the nodes. In larger networks, delays in completing the update transaction are proportional to network size: As the network grows, transactions will take longer to complete. One example of a file manager that uses a majority-update scheme is an experimental database network built at Xerox Research (see references for additional information).

Another method for updating replicas is the "as soon as possible" (ASAP) method. This technique involves designating one replica, the "master copy," on either a record-type or case-by-case basis, which ensures that the file at its node is updated. The updates are then asynchronously sent to the other replicas. This approach sacrifices consistency for availability and response time. Tandem's internal distributed database application, called Empact, is one that uses ASAP updates for frequently used data, and consistent updates for critical data.

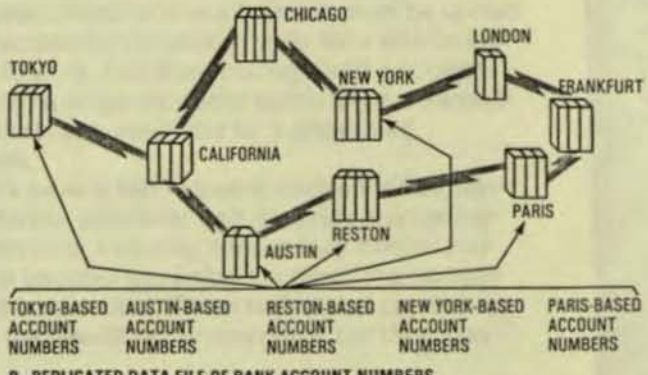
A different method involves a time-based technique, in which there is a master copy of the data record, and its replicas (or slaves) are "snapshots" of the master as of a specific time. The slave copies are periodically updated, and each replica is "time-stamped" to indicate its degree of currency. This technique is appropriate for files that change very slowly and for which currency is not critical to business operations. IBM's experimental "R" System provides this time-stamping of replicas.

When retrieving the time-stamped replicas, the degree of currency can be specified in the query. It may

2. Replication. *Local data files may be partitioned (A) at the same site. Global files, on the other hand, are replicated in each network node (B).*



A. PARTITIONED DATA FILE OF BANK ACCOUNT NUMBERS



B. REPLICATED DATA FILE OF BANK ACCOUNT NUMBERS

not always be necessary to read the most current copy, so some time and communications costs might be saved by reading a copy that is physically closer, but with an older time-stamp.

Relational

With data distributed all about a network, the retrieval method must be convenient and fairly simple to the user. This means that the database manager must keep track of all data locations in a manner that is transparent to the user. This requirement, combined with the flexibility needed to move data from node to node as information requirements change, makes a relational model almost a necessity in a distributed database environment.

A relational database stores data in two-dimensional tables of rows and columns containing related information (Fig. 3). Information is entered into the database by creating the tables and filling them with pertinent data. Expanding the database is a matter of adding new tables or adding new entries to existing tables.

Unlike hierarchical and network databases, the structure of a relational database is not determined and fixed when the database is defined. Data items are logically linked by the data management software on an as-needed basis, so data items are not dependent on other items (Fig. 4).

Connections between records are based on "soft pointers" (called keys), rather than "hard pointers," such as record addresses. This distinction allows the data at a node in a relational database to be reorganized without affecting other nodes. The relational data structure, it can be said, is dynamic and flexible, which makes it particularly suitable for a distributed environment.

Maintaining data integrity

A clear concept of a transaction is essential in coordinating multiple updates to distributed data. The multiple nodes and multiple copies of data items can mean distributed chaos if transactions are not carefully implemented and monitored. A transaction is an operation in which application procedures, such as banking operations, are mapped into transformations (by executing programs) that invoke database actions. These include: Read the customer, account, and teller records; write the account, teller record, and a memorandum record; and send response messages to a terminal. The result of this process should be that the database is moved from one consistent state to another.

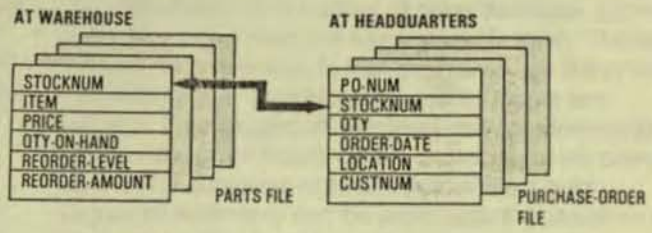
The key properties of a transaction are:

- Consistency—the transaction is a consistent transformation of the database state (for automated teller or banking transactions, that money is neither created nor destroyed)
- Atomicity (transactions are "atomic")—either all the actions invoked by the transaction occur, or else the entire transaction is nullified (in the banking case, that no account is left in a partially updated state)
- Durability—once a transaction is completed, its effects cannot be nullified without running a compensating transaction (funds removed from an account would have to be redeposited to be accessed again).

All of these criteria and requirements must be upheld uniformly across the network in order for a distributed database to work. Database management packages that consider a single database action to be a transaction, therefore, are unsuitable for a distributed environment.

There are several techniques available for maintaining consistency, atomicity, and durability in a centralized environment, including concurrency control and transaction backout (reversing the effect of a partially completed transaction). These techniques can also be applied in the distributed environment, but their man-

4. Linking up. *In this DDB transaction, a warehouse parts file is linked with a headquarters purchase order file to determine how many items are in a particular order.*



QUERY:

```
OPEN PARTS, PURCHASE ORDER
LINK PARTS TO PURCHASE ORDER VIA STOCKNUM
LIST BY STOCKNUM
     ITEM,
     QTY-ON-ORDER,
     ORDER-DATE,
     WHERE LOCATION = "SAN FRANCISCO";
```

RESULTS:

STOCKNUM	ITEM	QTY-ON-ORDER	ORDER-DATE
A76	TRIBBLE	500	05-19-82
G04	BLIVET	500	05-19-82
H73	WHATSIT	1,000	04-28-82
K88	BLURB	400	03-06-82
M36	PLAZZER	50	04-15-82
T05	KRUPUS	535	02-17-82

3. Relational. *A relational database differs from the hierarchical database in that common elements in the file permit records to be logically connected.*

CUSTOMER

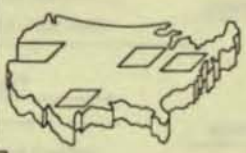
CUSTOMER NO.	NAME	CITY	CREDIT LIMIT
101	ACME	NY	500
102	SMITH	ATLANTA	1,000
216	JONES	SF	1,000

ORDER DETAILS

ORDER NO.	STOCK NO.	QTY.
123	A43	10
123	G04	100
124	E96	50

PURCHASE ORDERS

P.O. NO.	STOCK NO.	QTY.	ORDER DATE	CUST. NO.
27560	A43	10	1/10/82	102
13892	A76	43	1/30/82	101
42610	C61	2	2/2/82	216



PARTS

STOCK NO.	ITEM	PRICE	QTY. ON HAND	QTY. ON ORDER
A43	WIDGET	2.98	200	10
A76	TRIBBLE	4.39	40	500
C61	PLINTH	1.53	800	0

agement on a network-wide scale becomes much more complex due to the added communications considerations.

To ensure database integrity in a distributed transaction, all messages between nodes must arrive safely, and the sending node must be made aware that each message has in fact arrived. Both requirements can be met by using a "two-phase commit" protocol.

"Committed" transactions

A two-phase commit protocol uses a commit coordinator program to centralize the decision to commit or abort a transaction. The commit coordinator has a communications path to all the participants of each transaction. These participants, it should be noted, can be processes, autonomous components within a process, or both.

The commit coordinator asks all the participants to enter a "prepare" state, from which each participant can either commit or abort its part of the transaction. Once all participants are in the prepare state, each will transmit a message indicating this to the commit coordinator, which in turn can send a commit or abort message to all the participants (Fig. 5).

Once the commit coordinator sends the commit message, it waits for an acknowledgment from each participant before terminating the transaction. Use of this two-phase commit protocol helps ensure the integrity of a distributed transaction.

Distributed administration

Management of a worldwide database must be both distributed and centralized. Certain aspects of the database are common to the entire network and therefore must be designed and controlled by a central organization. A prime example of this is the global record format.

Local database functions can be controlled at the local node to provide site autonomy, which is one of the basic goals of a distributed database. An example of one such local function is a report format.

A hierarchy of control can therefore be imposed, with network-wide functions being managed by a central organization and control of other database activities being distributed in a hierarchical fashion. The key requirement, however, is that each level use the protocol of the global architecture for all its inputs and outputs. Each organizational level has an administrator, who publishes and controls the protocols of his component of the database network. And while a great degree of autonomy can be exercised, the structure of levels and control at this level should parallel the structure of the overall organization.

DDB selection

The choice of a distributed database management system is naturally dependent on the application requirements. However, care should also be taken to implement sufficient flexibility into whatever database network is constructed, to account for rapidly changing application requirements.

Requirements of a true distributed database include the ability to distribute data files between at least two computer nodes: to provide location transparency between data and users; to retain data file relationships (even when the files are located at separate network nodes); and to ensure transaction integrity in the distributed environment. The two commercially available distributed transaction management systems that most closely meet these requirements are IBM's CICS/ISC and Tandem Computers' Encompass. The ISC feature of IBM's CICS provides for distributed transactions and the ability to access remote files, but it does not transparently handle data partitioning or replication.

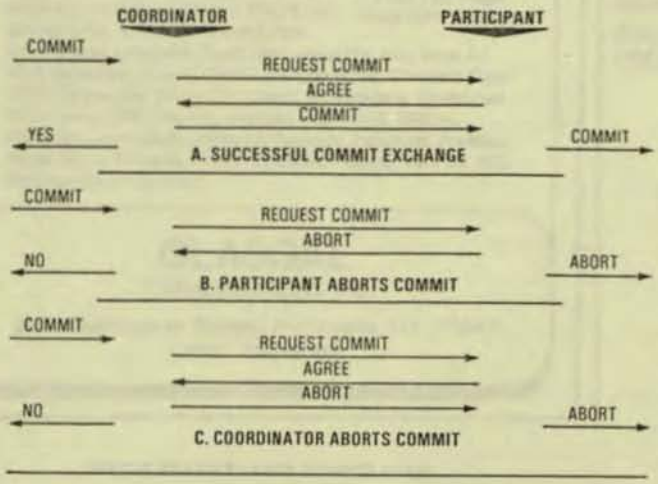
Data partitioning requires direct action by an operator with IBM's CICS/ISC, while this is done automatically—transparently to the operator—with Encompass. Manual intervention is also required with the IBM product for data replication, but Encompass requires manual intervention only for files resident on a remote node.

Another selection criterion is flexibility, since one of the purposes of a distributed database is to allow for the changing information needs of a corporation. The ability to add nodes, delete nodes, and reconfigure the distribution of data without changing application programs is a requirement.

Inherent in all of these requirements are a reliable data communications and networking capability, and the use of a relational database model. Without this base on which to build, no distributed data management network can be successful.

Beyond these basic requirements are some features that will enhance the usefulness of the database throughout a lifetime of changing requirements. One way of achieving this goal is through the use of highly reliable hardware and network software. Even though the database must be designed so that a failure at one node cannot prevent access to critical data, the distributed network will be much more efficient if extraneous hardware and software failures can be kept to a

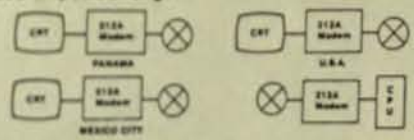
5. Commitments. *A dialog between the commit coordinator and a participant (A) ensures that transactions will be completed. The commit coordinator has a path to all participants, any of which may abort (B and C).*



THE DATA DETECTIVE # 8

The Case of the Chauvinistic 212A

A large bank in New York City installed a 212A on one port of a computer to allow remote branches to access a new specialized data-base. The first branches to use the new system were in the eastern part of the United States. Their calls were answered properly and the system functioned quite normally. Since the system worked so well, it was decided to allow overseas users to access it as well. Therefore, identical 212 modems were sent to and installed in Panama, Mexico and the Caribbean, but when Panama or Mexico called New York the New York modem would answer the call, send answer tone and then, after a few seconds, hang up for no apparent reason. Strangely enough, calls from Puerto Rico were accepted by the modem. Clearly, this 212 had strong nationalist tendencies and could understand Spanish. Changing modems in Panama and Mexico had no effect, so clearly, the problem was in New York but why would or how could a simple modem discriminate between calls based on point of origin?



A closer examination of the sequence of events showed that foreign modems heard answer tone but never received carrier from N.Y. after that. Therefore, after a few seconds, they ceased sending originate carrier which, in turn, caused a loss of carrier disconnect in New York. For some reason, answer carrier was not reaching the foreign locations even though answer tone did. Voila! On the long foreign calls there was an echo suppressor on the line that was not disabled, so that when originate carrier was on the line, answer carrier going in the other direction was attenuated. But, answer tone is supposed to disable echo suppressors and prevent this sort of thing from happening. A quick measurement of the modem's answer tone frequency showed it to be 2425 Hz instead of 2225 Hz (U.S. Domestic), or 2100 Hz (CCITT V.22), too high to disable echo suppressors. Changing the modem in New York ended the chauvinistic proclivities of this banking system.

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minimum. The ideal, of course, is to maintain data availability in the face of component failures or temporary inaccessibility of some network nodes.

Evolution

The linking of highly reliable computers into a single distributed database is not easy, but progress in this area and the availability of proven products is making this once blue-sky objective possible to achieve. That computer networks will move in this direction is inevitable.

Information management schemes, now computer-based, are replacing traditionally paper-based ones. But these earlier operations were not totally inefficient—the paper was invariably located at the point where it was most often used. The move to centralized data management procedures changed all that, though it came about more from a need to optimize expensive computing resources in the earlier days of computer technology than from the desire to centralize information resources.

With the cost of hardware rapidly decreasing and the reliability of data communications steadily increasing, the time has come to return to an information management operation that puts the data back where it is needed, as long as it can be done without sacrificing the advantages of a centralized database. Distributed databases are therefore the logical continuation in the evolution of computer usage for information management. And this evolution has been considerable: from compact data storage, to early database management systems, to the on-line access of centralized data, to remote data processing, and now, finally, to the distributed database management system, which promises to provide accurate and consistent data to all users, acceptable response time, and availability—even through otherwise catastrophic communications and hardware failures. ■

■

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When the shoe's on the vendor's foot: A look at Tandem's corporate network

When a computer vendor sets up an internal network using its own products, outsiders may see what the machines can really do.

As part of an ambitious internal communications and information management strategy, Tandem Computers Inc. has used its own hardware and software products to build a vast corporate network. The data communications web contains 200 nodes and spans 18 countries. Users in such countries as Japan and Australia are tied to sites in the United States, Canada, and Mexico, as are offices in the major commercial centers of Europe.

Over a hundred different applications run over the in-house network. Perhaps the most important of these is electronic mail. Roughly 70,000 messages are originated, and 250,000 are delivered each week to and from users throughout the world.

The widely used electronic mail is joined by a number of more specialized applications. For instance, the company's various manufacturing groups maintain their records in a distributed database. A battery of financial packages is available to network users, including tools for order entry, invoicing, credit and collections, and budgeting. A network-based program is also available to process requests for product enhancements and to track the actions taken in response.

In addition to the applications, many databases and information resources are accessed via the network by domestic and international Tandem workers. A "public" database, accessible by anyone in the company, contains information on employee office locations, office telephone numbers, department affiliations, facsimile and mail drops, and so on. Customer lists, notes about software, and other marketing information are listed in a customer-reference database.

An innovative archive of technical information has been compiled primarily from electronic mail exchanges. Another database, set up as an electronic bulletin board, provides a central source of support information. Field salespeople, responding to requests for proposals, make use of a constantly expanding collection of proposal text files.

Resources like these have become indispensable to nearly all Tandem employees. Since data communications is so important to the way the company does business, developing and maintaining the corporate network has become a leading concern.

Topology

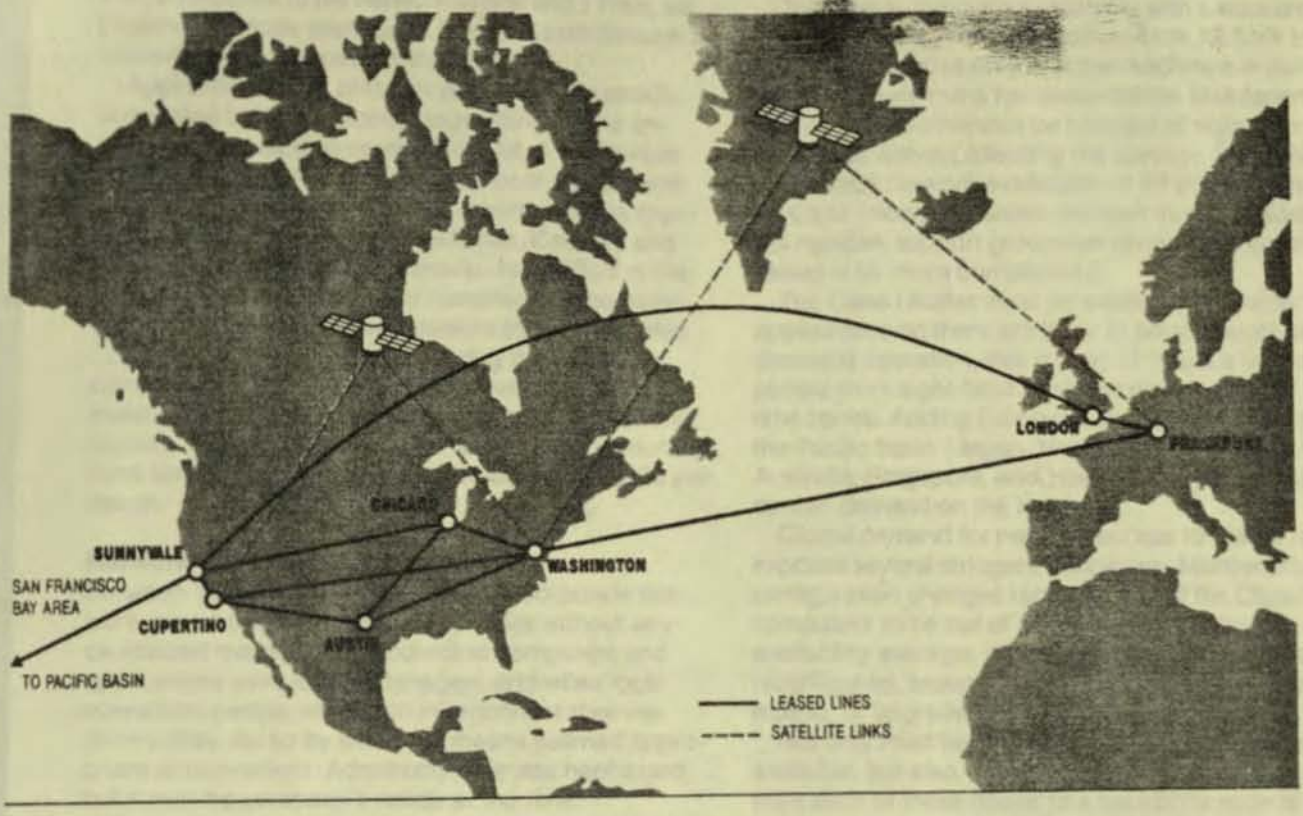
Management has insisted that the corporate network be built using standard Tandem products. Thus, each node consists of a multiple-processor computer in the NonStop line. Standard Tandem communications software and hardware are used, and databases are managed by standard Tandem products as well.

Of the 200 computers in the corporate network, 193 support applications and databases. These application nodes exist primarily to meet local word- and data-processing needs. However, they do handle communications for local users and applications, and they accept passenger traffic from other nodes.

The application nodes are built around seven "backbone" nodes that are dedicated to communications (Fig. 1). These nodes are linked by leased high-speed lines and, in several instances, by high-bandwidth satellite or microwave links. The backbone nodes have only one job: to be constantly available to move information between application processors. Roughly 1,500 Mbytes of data flow through them each day. There is, in addition, a substantial amount of regional traffic that never reaches the backbone nodes.

Connected directly to the backbone nodes are "Class I" nodes—machines that run accounting, manufacturing, and customer-support applications. These programs must be available if the company is to do

1. Over a billion and a half served. *Tandem branches from Osaka, Singapore, and Sydney to Neufahrn in West Germany can reach each other, as well as programs and data in the United States, via an extensive, internal computer network. The seven backbone nodes handle 1.5 billion bytes of traffic a day.*



business, and thus the nodes in which they run must always be accessible from a backbone node.

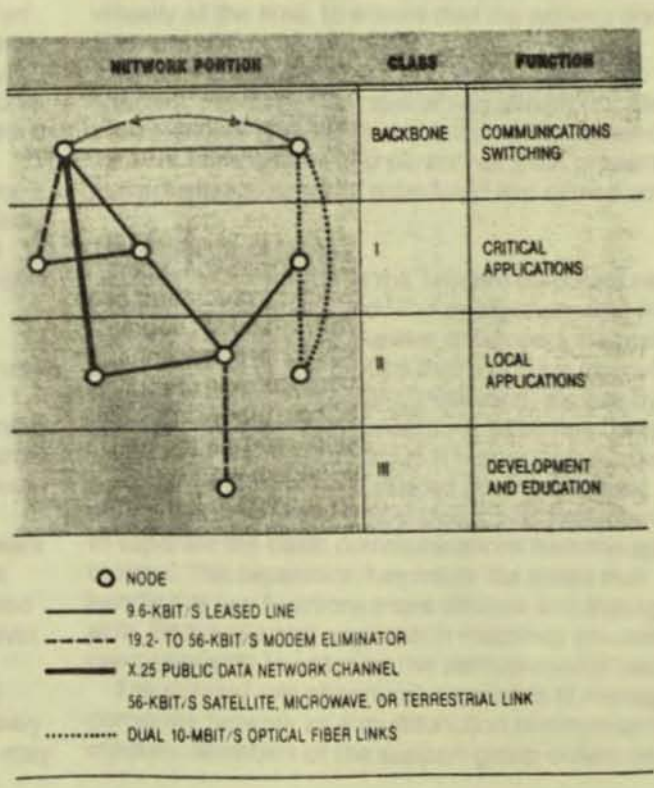
The network's 26 Class I nodes are always linked directly to at least one backbone node and either directly or indirectly (through another Class I or Class II machine) to a second backbone node (Fig. 2). Each machine is thus part of a ring. This dual-path policy has been established to provide uninterrupted network service. It ensures that even if a backbone machine, a communications line, or a modem fails, the Class I node will not be cut off from the network.

Over a hundred network nodes are Class II. They typically serve field sales and service offices, running local applications and less time-critical network applications such as electronic mail. Thus, they need access to the network, but response-time and availability requirements are not as stringent as in the case of Class I nodes. Class II nodes are connected no more than two nodes away from a backbone machine (or a high-speed lightwave cluster, as in Figure 2) whenever possible. They also each have an alternate path to a backbone node—and thus to the rest of the network.

Class III nodes are used primarily for development work or customer education, not for running network applications. They are often intentionally overloaded, brought down, or crashed to debug and test the capabilities of software products and, therefore, are not always connected to the network. They are also used to give customers and internal support people experience in loading machines and handling recovery.

continued

2. Architectural outline. *In this sample layout, all applications nodes except for the development machines have at least two paths to the backbone network.*



When any of the 63 Class III nodes is connected to the network, the connection is either through a ring or a spur composed only of Class III nodes. (A spur is a group of nodes strung along a communications path that is attached to the network at one end.) Thus, no higher-class node ever has to rely on a path through a Class III node for access to the network.

Application nodes of the three classes are usually connected to the backbone nodes (and to one another) via leased lines or satellite links. A microwave scheme from M/A-Com with Coastcom multiplexers joins the two California backbone nodes. Some application nodes, most notably in Mexico, Canada, and Europe, are linked via X.25 circuits. In addition to the node-to-node lines, there are numerous connections from terminals and terminal clusters to nearby nodes.

Tandem believes that, considering the size of the company and the network, it pays very little for communications. Expenses for domestic and international circuits, satellite links, modems, and other communications services are in the neighborhood of $180,000 per month.

Network management

Between 1979 and 1981, the Tandem corporate network grew from zero to about 40 nodes without any centralized management. Individual computers and applications were locally managed, and when local operations people wanted to interconnect their machines, they did so by whatever means seemed appropriate or convenient. Admittedly, this was haphazard, but it met the company's needs at the time.

During this three-year period, the average availability of Class I nodes over the network was low, not because of a problem with the computers themselves, but because no thought had been given to network architecture. At first, the 40 computers had been linked in star fashion to several central machines at corporate headquarters, to facilitate order-processing activities, communications between software developers, and so forth. However, disruptions in the star network could isolate users from resources in the network.

No provision had been made for alternate communications paths. Thus, line and modem failures inevitably isolated at least one node (and sometimes several) from the rest of the network. This also occurred when a node in the middle of a spur was brought down for maintenance or configuration changes.

In response to difficulties of this kind, a small network support group was formed in 1981 to evaluate the situation and address the problems involved in running a large multifunction network. Within four months, the backbone structure was put into place and rings were formed to provide less-interruptible service.

Network-oriented node-management practices were also instituted. For example, Class I nodes were not allowed to leave the network without being scheduled by the support group. Test software required approval before being let loose on the network.

As a result of these changes, the average Class I node availability rose dramatically and is now routinely at the 99 percent level. At first glance, this statistic may be misunderstood. Vendor hype usually includes claims of high availability. The respectability of these claims depends on how the term "availability" is defined. One must examine what underlies this kind of statistic.

To achieve complete availability with a standalone computer during five consecutive 8- or 12-hour business days requires only that the machine run during these days without a hardware failure. Maintenance and reconfiguration can be handled at night or on weekends without affecting the average. But achieving an average network availability of 99 percent running 26 Class I nodes for seven 24-hour days per week (as the network support group has done for almost three years) is far more complicated.

The Class I nodes must be available whenever the applications on them are likely to be accessed. In a domestic operation, this means 12 hours a day, since people work eight-hour business days in each of four time zones. Adding European users, and now users in the Pacific basin (Japan, Hong Kong, New Zealand, Australia, Singapore, and Hawaii), has put an unprecedented demand on the network.

Global demand for network access to Class I nodes imposes several stringent conditions. Maintenance and configuration changes requiring any of the Class I computers to be out of service count against the availability average. Whenever these computers are reconfigured, brought down for software changes, moved, or upgraded, the downtime is noted.

Not only must each Class I application node be available, but also, at least one communications path from each of these nodes to a backbone node is required continuously. This path may include several modems and lines and, on occasion, a Class II node, all of which must be available if the path is to be used. Finally, the backbone network itself must be available virtually all the time, to ensure that the primary and alternate communications paths are usable.

Given the above details, it is easy to appreciate what underlies the 99 percent availability statistic for Class I nodes. Global operations make incredible demands on network components and personnel. Even preventive maintenance is carefully scheduled and carried out.

The division of labor

Application nodes within the Tandem corporate network are locally managed. The applications that make use of the network are likewise developed, maintained, and managed by the groups that use them (manufacturing, capital management, marketing, etc.) or by specially designated organizations within the company.

The network support group is responsible for the backbone machines and related communications equipment. The backbone concept was implemented to separate the basic communications from the applications. This separation has made the nodes that handle the two functions more efficient and manageable. Backbone and application machines are configured differently to optimize the performance of each.

The primary role of network support is to manage the corporate network as a multifunction communications medium. Members of the support group collect data on

network operations, manage the backbone machines, and troubleshoot line problems. They also train operations people at each node to consider the impact of their actions on the network at large.

Group members investigate and make recommendations on new hardware, software, and line services that might enhance the usefulness and responsiveness of the network. They must also plan for and maintain a sensible network architecture. This means treading a fine line between cost-effective implementation and satisfactory availability and response time.

The means to keep growing

Since 1981, the network support group has overseen the growth of the network from 40 to 200 nodes. Yet the group has never consisted of more than six people. The work of this group is simplified by the architecture and operating system of the computers used in the network. Each node consists of a computer designed for "failure tolerance" and expandability.

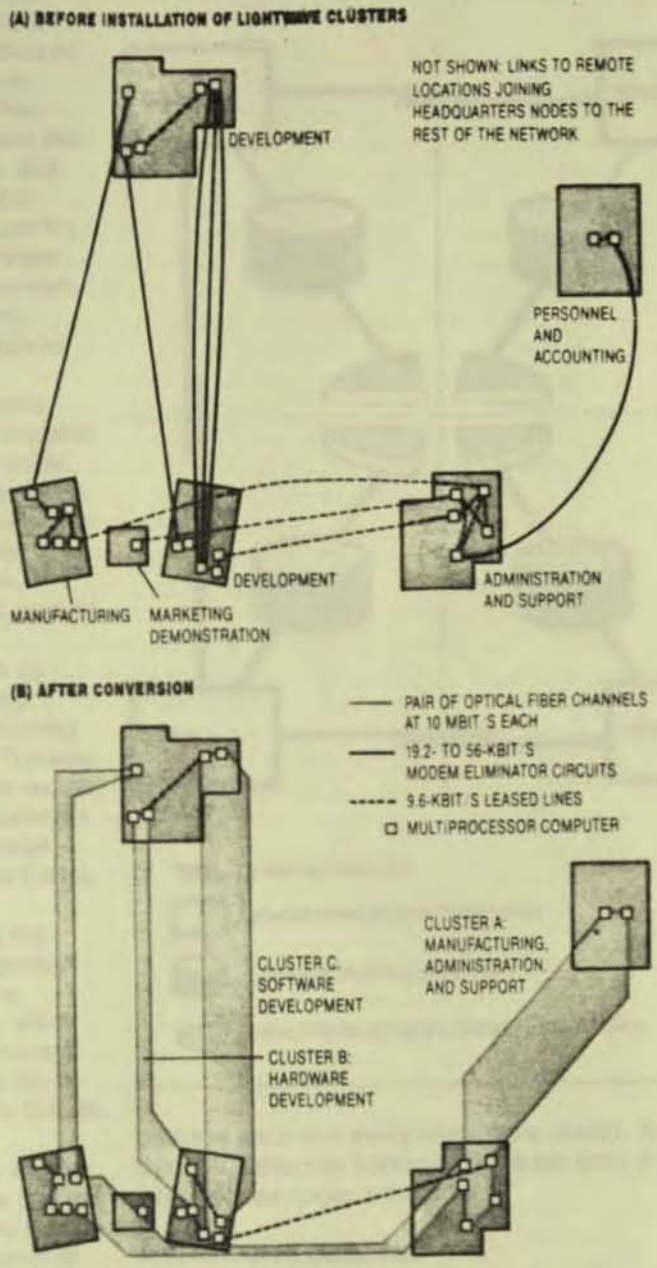
Failure tolerance refers to the ability of these computers to continue to function in the face of any single component failure, including a processor failure, and to the fact that it is possible to repair and reintegrate a failed component without shutting the computer down. This feature is important to the functioning of Class I nodes in Tandem's global network.

Expandability refers to the fact that a single machine can consist of anywhere from two to 16 cooperating processors. Guardian, the distributed operating system that manages resources for each multiprocessor node, allows the machine to grow through that range without requiring any reprogramming of applications. This means, for example, that operators of a NonStop TXP machine can increase the processing power of the computer from roughly four million instructions per second (MIPS) to 32 MIPS without having to change a single line of code.

Where even more local processing power is required, up to 14 of these computers (for up to 224 processors) can be linked locally in a ring via a Tandem software/hardware product known as the Fiber Optic Extension (FOX). This link is almost as fast as the internal bus that links processors within a single machine. The data transfer that takes place over the link is managed by the same operating system mechanism that handles traffic within a single multiprocessor node (independently of the input/output channels of the processors). As a result, the entire local subnetwork thus created can be used as if it were one large machine with a processing capability of 448 MIPS (14 nodes each with 16 two-MIPS processors).

The reliability and local expansion capability of the computers used in the Tandem corporate network make the network far easier to manage than it would otherwise be. As explained above, the operating system running in the local machine has the ability to make multiple processors appear to users and programmers as a single unified resource. In a network setting, this operating system also has the ability to blur node boundaries. The operating system and associated networking software permit operations people

3. Rings of light. *Computers in buildings at company headquarters are being linked into lightwave rings. The portions of the rings within buildings are now complete.*



and users to log on to their local machine and do work on remote nodes.

For example, they can type in successive two- or three-word commands that will start a program on a machine in New York, instruct that program to access a file in a disk volume in Atlanta, and print out the results for another employee on a device attached to a computer in Chicago. The command syntax by which these operations are carried out is identical to those that would be used locally for similar operations, except that, in each case, a node specifier must be added to the program, file, or device name.

Five of the seven backbone nodes in the corporate

network are managed remotely from control points in Cupertino, Calif., and Frankfurt, West Germany. If, in the course of routine monitoring (or as a result of a telephone call from users), network support people detect a noisy line that is causing delays and timeouts, they can run tests to identify what kind of noise is present and then, if necessary, bring down the line.

The networking software will immediately detect this change, update the routing tables in each node, and automatically channel messages over an alternate path. Network support people can then simply call the telephone company personnel to report the problem and let them fix it. When the problem is fixed, network support brings the line back up and, at that point, network software updates the routing tables again to indicate that the old path is available.

Adding a node to the network involves little more than plugging it in. The local organization finds physical space for the new machine and sets it up. Meanwhile, the network support group orders the communications lines and assigns a node number and node name to the new machine. When everything is in place, the local operations people attach the machine to the line, activate the line handler with a single command, and let the networking software do the rest.

When the new node is attached, it announces its existence to its immediate neighbor. The neighbor sends the node a copy of its routing tables containing information about all the other network nodes. The new machine then sends greeting messages to those nodes. After receiving such a message, each node updates its routing tables. Only operations people at the nodes connected directly to the new one need to know that a change has occurred.

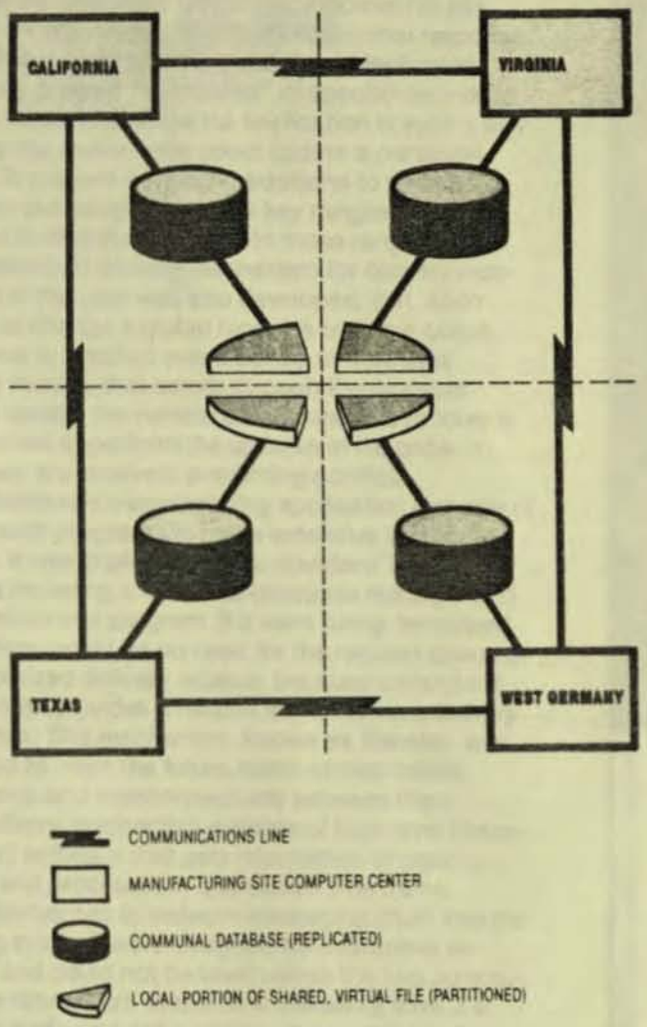
The network support group is currently using the lightwave product described above to link computers at company headquarters into rings (Fig. 3). The machines are joined by 9.6-kbit/s leased lines, with modems from Codex Corp. and Halcyon Communications Inc. Intrabuilding connections are 19.2- to 56-kbit/s RS-449 modem eliminators from Compre Comm Inc. or ARK Electronic Products Inc.

With lightwave links in place, up to 14 nodes will be able to communicate with each other almost as fast as the multiple processors within a given node. The link joining machines into a high-speed cluster consists of four fibers, two each for transmit and receive channels, configured in a ring at 10 Mbit/s per fiber.

Implementing the headquarters' architecture shown in Figure 3 will reduce the processing overhead associated with networking, since a controller, rather than the machines participating in the ring, will process pass-through traffic. In addition, functional groups of computers and users will be consolidated and certain replicated databases will no longer be needed, since it will be possible to access a database on another node in the ring almost as fast as if the database were locally attached.

Another reason for moving to lightwave technology is its improved reliability. The current architecture provides only two paths from most machines to the network at large, while the lightwave rings yield four paths to each and every node in the cluster. Also, pass-through traffic can continue over a link even if the intermediate nodes are down.

4. Breaking up is hard to do. *In this distributed database, communal data is replicated at each site, and local data is partitioned among the sites.*



A distributed database

Nearly all phases of Tandem's business depend in one way or another on services that the corporate network provides. As mentioned earlier, over a hundred different applications run over the network. Numerous databases and information resources are also available remotely. One sophisticated application developed by and for the manufacturing organization uses the network to maintain a distributed database.

Tandem has manufacturing plants in four locations: California, Texas, Virginia, and West Germany. Each one has a fair degree of local autonomy but similar information needs. Managers and employees at each plant need access to communal data, such as the company's comprehensive parts catalog and bills-of-materials (lists of parts that go into specific assemblies and finished products). For their own shops, they must

keep a close eye on local information. This includes production schedules, materials requirements, purchasing of parts, receiving, inventory, interplant materials transfers, and work-in-process.

Originally, manufacturing information of this kind was maintained in separate databases at each site. This was good for autonomy because local information was under local control and communal information was always available, even when communications lines or distant computers were down. However, it also meant that communal data (such as the parts catalog and bills-of-materials) was often inconsistent from site to site. Monthly, there were typically 4,500 updates to the bills-of-materials files and 1,000 to the parts catalog. Thus, the copies of these files used at the various sites had to be updated and reconciled once a week.

Anticipated growth in the number of manufacturing sites was bound to increase the need for local autonomy. As each site's functions became increasingly specialized, so did its data requirements. At the same time, growth would aggravate the problem of consistency. Sites would need better ways to keep each other current and to share resources. Anticipating this, manufacturing information planners decided to use the network to provide an integrated, distributed resource.

The application they created distributes data across the network in two ways, as shown in Figure 4. Communal data, which is used heavily at each site, is replicated so that all manufacturing sites have ready access to it. Local data, which consists of records of interest only to users on particular nodes is stored at those nodes. The files containing those records are partitioned across the network.

Reads and updates of local data are easy because the information is on the local node and because there is no need to inform any other node of changes. Reads are also easy with replicated data, because the files are available on the local node. Updates of replicated data are more complex, however, because the local update cannot be considered complete until copies at all other remote manufacturing sites have been updated as well.

The designers of the application had a choice of how to handle these remote updates. One strategy would be to include the updates as part of the local transaction and not consider that transaction complete until the relevant records on all remote manufacturing nodes had been successfully updated. This would have a substantial negative impact on response time for the user requesting the local update, whose terminal or process would be suspended until update requests traveled to, and were completed by, all other nodes. It would also mean that if, for some reason, one of the remote nodes were inaccessible, the transaction could not be successfully completed, even on the local node.

Another approach would be to let the local software incorporate some kind of independent delivery mechanism. This mechanism would take responsibility for updating communal data on remote nodes as soon as possible after the local update transaction had been completed. The "asynchronous delivery" approach would mean that replicated files would be inconsistent for brief periods of time, until the independent delivery mechanism completed its work. It would also introduce the possibility of concurrent (and inconsistent) updates of the same replicated record by different nodes.

The developers decided to sacrifice absolute consistency of the replicated files at every moment in exchange for site autonomy and short terminal response times. To prevent conflicting updates to replicated data, they granted "ownership" of specific records to specific nodes and wrote the application in such a way that only the owner node could update a particular record. To prevent conflicting additions to replicated files, they pre-assigned various key ranges to certain sites and limited the additions to those ranges.

A customized delivery mechanism for delivery independent of the user was also developed. In it, each request to change a global record is put on a queue. This queue is emptied over a period of time by a software module that scrolls through the requests trying to update the remote databases. The module is programmed to perform the updates in the order in which they are received, preventing conflict.

The distributed manufacturing application was one of the first such programs to make extensive use of the network. It was implemented via standard Tandem products including a relational database manager and a terminal control program. If it were being developed today, there would be no need for the request queue or the customized delivery module, because a standard product now provides a reliable asynchronous delivery mechanism. This mechanism, known as Transfer, was developed to meet the future needs of distributed applications and interconnections between them.

The delivery mechanism consists of high-level (transport layer) software that gets information to people, devices, and processes in a specified time frame. Earlier approaches to network messaging (built into the operating system) were designed for interactive exchanges and could not be used unless the two communicating entities were available at the same time. If a particular node was not available, the user (or program) took responsibility for trying again at a later time.

The new software was designed to overcome this limitation. It attempts to deliver messages as soon as possible or within a specified time frame. If unsuccessful on the first try, it takes responsibility for periodic retry attempts thereafter. Delivery of the message or information package once and exactly once is guaranteed. If line failures, node failures, or disk controller failures make delivery impossible within the time period specified, the delivery mechanism notifies the requester of that fact.

Supporting support

Sales and service offices exchange information with hardware and software support centers by means of a product-reporting application. This network-based program provides a way for a field analyst (or, indirectly, a customer) to report a perceived engineering defect or bug, to request an enhancement to a product, or to ask a question concerning a product.

Field personnel enter product reports on software screens generated by the reporting application. Once a

product report has been entered, the application forwards the report over the network to the appropriate support person. (If no support destination is specified on the report, an administrator decides where the report should go and forwards it.)

Although a report can be sent from any node to any other node (where both nodes have the application), it is normally sent from a field sales and service office to one of several regional technical support groups. In some cases, the regional group will be able to supply an answer and will simply return the report to the originating node. In other cases, the regional group will send the report to the corporate technical group, which will then either answer it or forward it again to the appropriate software or hardware development group.

Whenever a report gets forwarded, the application uses its electronic-mail interface to send a message to the report's originator. This keeps the person with the problem abreast of who is working on it. In such cases, the application also generates a mail message to the analyst to whom the report has been referred, as a reminder that someone is waiting for an answer.

Regardless of the exact path of a particular report, when a response is complete, the report is "returned to the field." All information pertaining to the problem is automatically collected and sent to the originating node by the application. To inform everyone concerned how the problem was resolved, and to make it easier to handle like problems in the future, an updated copy of the report (with the response) is automatically sent to all nodes that the report traveled to during its lifetime.

In addition, the application maintains a database on each individual node that contains all reports originated from that node as well as those that have been sent to it from other nodes. Thus, there is a fair amount of replication of the application's data throughout the network, even though each node has only a subset of the entire problem-reporting database. The database is frequently accessed by support personnel to identify outstanding problems that have already been reported, thus eliminating duplication of effort and ensuring faster resolution of problems for all customers.

Help for the business side

The network offers resources aimed at groups besides manufacturing and support. Business functions, from closing sales to processing orders to reporting financial data, have been computerized. Most of these are traditional, centralized applications, but some make extensive use of the network.

Products are built because someone wants to buy them. To help sales representatives sell them, the marketing department maintains a customer-reference database. Field salespeople who learn how customers or software houses use their products can submit that information to the database. Their colleagues can then view the data over the network and generate reports by industry, by application, or by product.

In this way, sales representatives can identify existing customers who might be able to help future ones. The customer-reference database is also a source of ideas on what to propose to prospective purchasers. And finally, a complementary-products listing provides a catalog of software packages available in the marketplace that can strengthen a representative's offerings.

Salespeople worldwide must often respond to "requests for proposals" because these requests usually present substantial opportunities. To eliminate the need to reinvent the wheel each time a proposal must be written, a headquarters proposal-assistance team maintains text files, accessible over the network. While they do not eliminate the need for writing and analysis by field sales, the text files substantially reduce the time it takes to prepare a customized proposal.

Once a sale has been made, it must be accounted for and the order administered. Contracts are sent to a sales administrator who verifies them and enters them into a marketing support application. The application sends an "electronic packing slip" to a manufacturing group. The message tells manufacturing to build and ship the order.

When the ordered equipment is shipped, a manufacturing person logs on to the marketing application and marks the order complete. (Order status is reflected in daily reports that are sent by the application to regional sales and service offices over the network.) The application then sends a message to an accounting and invoicing routine, telling it to bill the customer.

The accounting and invoicing application is tied to a database of ledgers, which it updates when bills are sent or payment received. It supplies sales reports to management people and answers their queries. It uses the network to broadcast reports to field offices and to tell accountants at the manufacturing site when a piece of equipment has been booked as a revenue item.

The budget model is another financial application that runs on the network. This tool is used by every organizational unit within Tandem in preparing capital asset and operating budgets for the coming year. Managers enter basic salary, hiring, and expense data on specially formatted screens, and the model calculates monthly, quarterly, and annual totals and generates reports that are used in evaluating spending plans.

The budget model provides software that rolls, or merges, the budgets of various groups together automatically and generates an overall budget for larger organizational units. The results of local calculations can be forwarded over the network to headquarters where they are used in forecasting cash requirements and ensuring that a reasonable level of profitability is achieved by the company. ■

This is the first in a two-part series on Tandem's internal network operations. The second part will focus on electronic mail, the company's most widely used application, and take a closer look at network hardware and software.

Kent Madsen is the editor of the Tandem Application Monograph Series, produced by the company's field productivity program. David Foley is the technical manager of the Tandem network. Foley is responsible for architectural and strategic planning, analysis, and operations support.

Datamation 1/1/85

A new, cohesive integrated architecture is expected to emerge within the next five years.

IBM: MAINFRAMES IN 1990

by Norman Weizer and Frederic Withington

COLLAGE BY MARK YANKUS

This forecast is based on an analysis of three factors: the needs of IBM's large customers; the potentials of technology, particularly the kinds most familiar to IBM; and IBM's self-interest. Although the forecast is unlikely to be correct in every detail, we believe its overall direction is accurate.

By 1990, IBM will have evolved an integrated architecture encompassing all its multiple product lines. This architecture will be based on the following components:

- the SNA overall communications architecture,
- the DCA document content architecture,
- the DIA document interchange architecture, and
- office and factory-floor local area communications architectures.

These integrated architectures will operate under an evolving MVS/XA umbrella with VM/CMS playing an important role for interfacing end users. According to its Feb. 23, 1984 guideline statement, IBM does not intend to implement these facilities in DOS/VSE. Therefore, by 1990 we expect DOS/VSE will have been stabilized and its use will be declining.

As the primary host operating system, MVS/XA is expected to be able to operate on mainframe systems composed of a variety of functional subsystems (see Fig. 1). The stabilized versions of DOS/VSE and the then-current version of VM/XA will thus remain operable as job entry subsystem (JES) or application processors under MVS/XA. The IBM modular mainframes will also permit IBM processors with older architectures to operate as subsystems. This will be especially useful for customers who resist conversion to the new architecture systems.

Within this overall architectural framework, DISOSS will be the primary subsystem for all document filing, search, retrieval, and output functions. While initially text-oriented, DISOSS is expected to evolve to have a full spectrum of integrated

...rs will be able to choose degrees of increased cost ... obtain increased levels of fault tolerance.

storage and retrieval capabilities, including ones for image, graphics, and voice (both limited voice recognition and speech synthesis). DISOSS is expected to provide compatible, revisable form document storage and interchange facilities for all of IBM's office automation systems.

PROFS will continue to evolve (under DISOSS) as an easy-to-use end-user subsystem in the evolved VM/XA environment. Its functions will be enhanced to encompass full revisable text interchange among the IBM multifunction workstations, as well as enhanced forms of the professional office automation functions it currently supports.

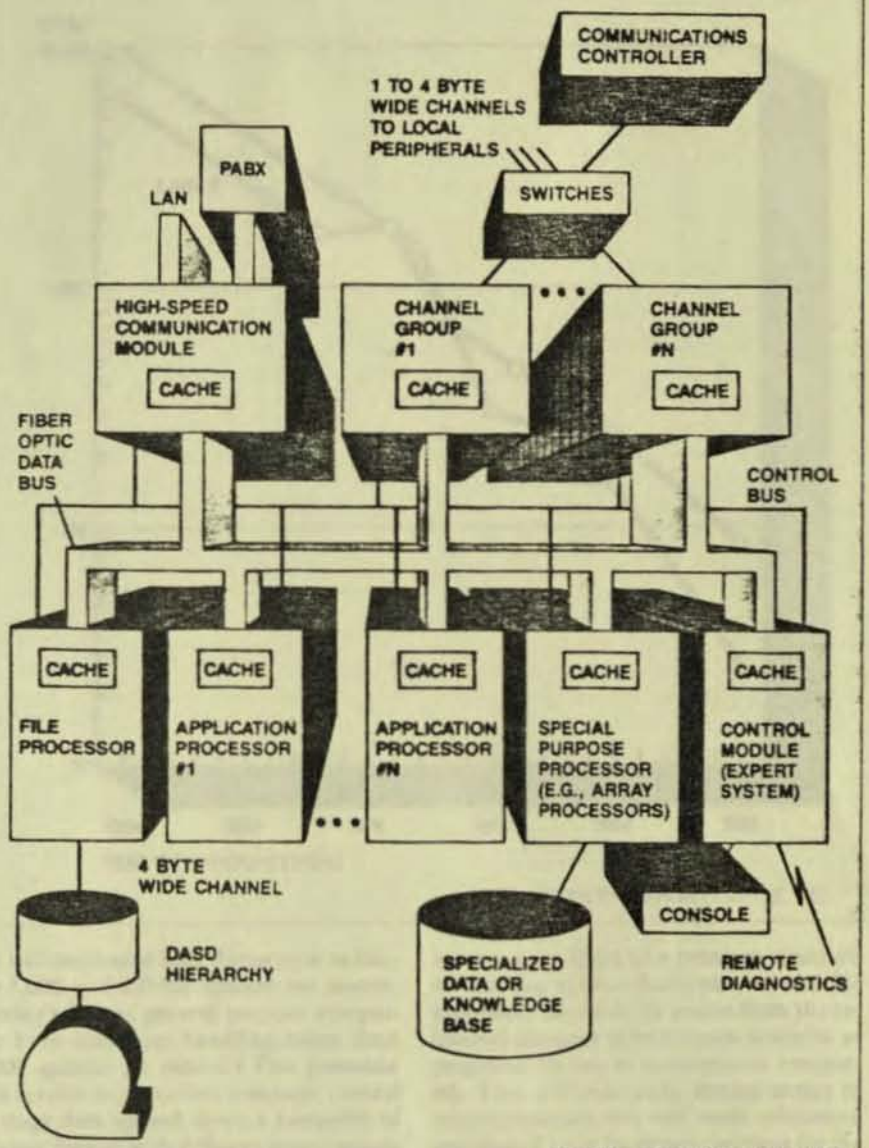
IBM's 1990 mainframe, then, will still play a central role in its overall architecture. It will be the central file manager and switch not only for data, but for objects in other media, and will of course retain its original role as a large scale batch and interactive processor when job sizes exceed the capabilities of network nodes.

By 1990, the electronic components available to IBM for use in its mainframes will cost no more than one tenth of current prices. Semiconductor memory chips, the largest of which now store 262,000 bits of information, will by then be storing 1 million to 4 million bits in the same area at about the same cost.

The cost of logic will also be lower. The 16-bit microprocessors now used in most personal computers have just passed the $10 price level; by 1993, they should be approaching $1 each. Similarly, 32-bit microprocessors with approximately four times the computing power will have dropped below the $10 level and will continue downward. These will be widely used throughout IBM's mainframes, and the still-needed higher-speed logic chips will also cost less.

FIG 1

IBM 1990 MAINFRAME HARDWARE ARCHITECTURE



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SPEED MAY IMPROVE FIVEFOLD

Speed may prove to be somewhat more of a constraint. Faster circuits require denser packing of circuit functions on the microchips, an arrangement that creates problems of signal strength, heat dissipation, and quality control. Gallium arsenide should be available as a substrate, however, together with smaller feature size and better cooling for silicon chips. We expect about a fivefold improvement in the speeds of the fastest routinely available electronics, and even higher performance with new technologies.

To take advantage of the low-cost but relatively low-speed components that will be available, IBM's mainframe system of 1990 will contain multiple processors dedicated to specific functions. Each processor will contain a very large cache (in excess of 1MB) that will in effect be a loosely coupled main storage facility. The specific function of each processor, e.g., the instruction set to be processed, will usually be determined by alterable microcode. The processors will communicate with one another via messages and data blocks in standard form, regardless of whether the content is a program, data, digitized text, image, or voice. The processors will also be able to back one another up, should any one of them fail (fail-safe). Fault tolerance will be available both at the system level and at the device and component level to accommodate the increasing demands of users for high system availability. Users will be able to choose degrees of increased cost to obtain increased levels of fault tolerance.

The largest mainframe models will be capable of supporting up to 16 general purpose processors as well as several special purpose processors. Smaller members of the mainframe product line will be able to support fewer and less capable processing subsystems.

...austive searches of large databases will be ...actical for the first time.

This mainframe-federated functional subsystem architecture will employ a fiber optic main data bus to interconnect the various functional elements, and probably a separate control bus.

Among the various optional functional subsystems offered in the product line will be

- several sizes of input-output processors,
- relational database processors and buffered file processors,
- application processors (for various programming language environments),
- array processor modules,
- image processors, and
- expert system modules.

Many of these modules will have hardware architectures specific to their intended tasks. Others will be software/microcode variants of the standard processing modules.

The input-output processors' sizes and characteristics will vary, including the capabilities of conventional channel groups and also new high-speed communication controllers. Among them they will be capable of communicating with several kinds of attached communications facilities and of switching messages between terminals (whether they contain data, text, digitized images, or voice). They will also control local batch input-output devices such as line printers, and existing DASD controllers if file processors are not used.

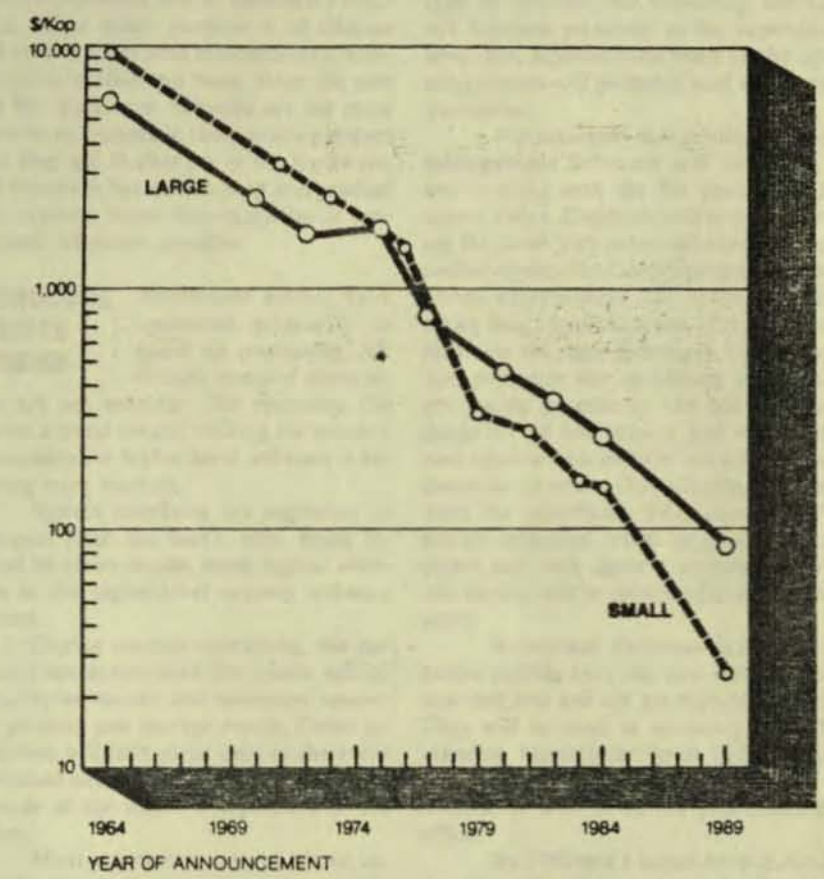
The application processors will be dedicated to particular computational environments. Some will be oriented to direct execution of programs written in specific programming languages (for example, COBOL or FORTRAN), while others will support problem-oriented languages (for simulation). Still others will run the software of obsolete machines. The orientation of each application processor will be specified by alterable microcode; within limits, the processor orientations can be changed via the supervisory processor to meet different workload requirements.

The database and file processors will evolve especially rapidly, based on evolution of the cache disk controllers (3880-21 and 23) and on hardware to support processing of relational databases.

FIG. 2

IBM: HISTORICAL PRICE PERFORMANCE

LARGE VS. SMALL MAINFRAMES



SOURCE: ARTHUR D. LITTLE, INC.

SPECIAL PROCESSOR VERSIONS

Also available for different kinds of applications will be specialized versions of file processors. Text, voice, and graphic data will be stored in the same databases as computational data, with unique query, search, and report generation routines to account for the special characteristics of the data processed.

One type of specialized file processor will emphasize high throughput to handle 1,000 to 5,000 file updates per second. (Today's largest general purpose computers have difficulty handling more than 1,000 updates per second.) This processor will involve sophisticated computer control to stage data up and down a hierarchy of storage devices with different access speeds (in accordance with patterns of use), and to handle a variety of storage devices arranged in parallel for simultaneous access. Such high-throughput storage systems will be useful in centers with the largest processing networks.

Other types of file processors will employ less structured methodologies so that associative or content-related inquiries can be made. These less structured file processors will be useful in office applications or research and information-retrieval applications. They will be useful in collecting and retrieving a variety of text and graphic materials, as well as data from a number of sources not subject to a common structure or indexing system. Such unstructured file processors are likely to evolve from the relational database software now available as programs for use in conventional computers. They will eventually employ arrays of microprocessors that will make exhaustive searches of large databases practical for the first time.

Other versions of file processing systems are possible for such things as voice or graphic information (which may be stored in noncoded forms). In the late 1980s and early 1990s, some processors will have special architectures adapted for artificial intelligence and/or data-driven applications.

In 1990, IBM will offer a broad family of these modular systems. This family will be headed by a tightly coupled confederation of very high speed general and special purpose processors with an aggregate processing power of over 100MIPS; the low end will extend down to workstations with

...gration of the DBMS and other software will form unified applications development and operations environment.

processing power of approximately 1 MIPS.

As shown in Fig. 2, IBM's current mainframe product line is characterized by two distinct price/performance levels. At the low end (4300), the systems average approximately $150/KIPS (one thousandth MIPS). At the high end (308X), the systems average approximately $250/KIPS. According to these price/performance trends, we project that in 1990, the low-end systems will be priced at approximately $20/KIPS and the high end at approximately $80/KIPS. The small systems pricing advantage will primarily be due to the lower performance components needed at the low end of the mainframe line, and the higher level of manufacturing automation that can be applied to production of smaller systems.

These prices are exclusive of separately priced system programs. By 1990, most IBM mainframe users will likely pay more on a life cycle basis for system programs than they do for hardware.

MVS/XA will form the primary system software environment for IBM mainframes in 1990. The current MVS/XA product will, however, be significantly modified between now and then. Most of the changes will take the form of additional and enhanced capabilities. IBM will be careful to change the existing program and JCL interfaces as little as possible to minimize customer compatibility and migration problems.

We expect the major MVS enhancements to include

- the addition of more functional subsystem capabilities,
- the addition of autonomous monitors to operate the various functional subsystems,
- the migration of increased amounts of code into the microcode of the various functional subsystems.

These enhancements will be needed because the operating systems accompanying modular computers must also become modular. Already, MVS/XA is undergoing a long-term, gradual transition from an easily identified, integrated collection of software to modular software and microcode-implemented sets of elementary functions whose major purpose is to allocate and control subsystem resources on a millisecond-by-millisecond basis. Since the user and his application software are far more sensitive to changes in the operating system than they are to changes in the hardware, this transition has to be a long and gradual one, avoiding major discontinuities or conversions, whenever possible.

MICROCODE ASSISTS A TREND

Microcode assists have appeared primarily to speed up processing. Although many of these assists are not necessary for operating the system, a trend toward making the assists a prerequisite for higher-level software is becoming more marked.

System interfaces are beginning to disappear from the user's view, being replaced by easier-to-use, more logical interfaces in the higher-level support software systems.

During normal operations, the operator's interaction with the system will be primarily to mount and dismount removable printing and storage media. Other interactions will take place only in the event of unusual situations like the failure of one or more of the major components of the system.

Most operators, except those involved with physical media, will probably be located in an operations control center away from the computers. Expert system components such as IBM's YES/MVS will be used to implement overall system scheduling and configuration policies.

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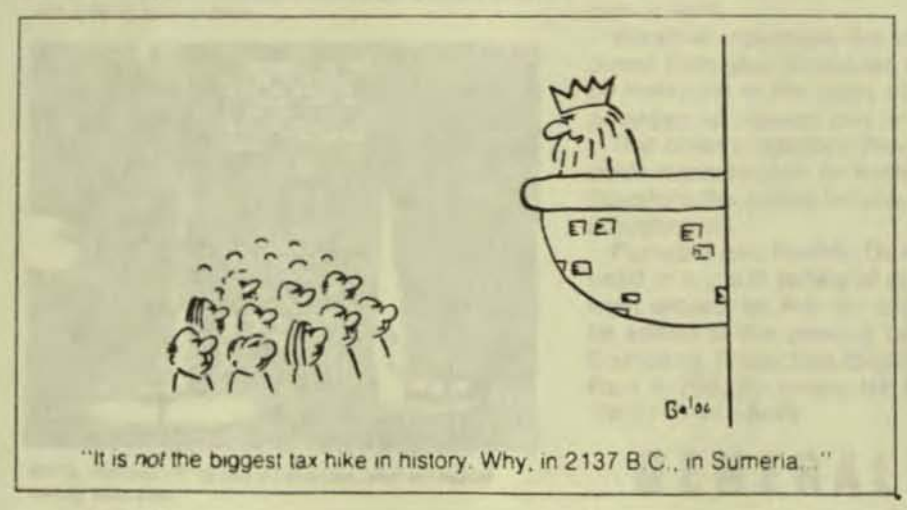

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We also expect expert systems from IBM to be of increasing importance for specialized applications. These systems will not be in widespread general purpose use by 1990, but will be important where they can be successfully applied.

These changes in mainframe architecture and price performance will have significant implications for users' information processing systems. Special-function-oriented mainframes will be common with significant capabilities in one area, such as file processing, and little capability in another area, such as scientific computing. Thus large users will be able to economically configure special purpose processors that can be distributed to departmental locations without special environments.

The new architecture will also allow mainframes to be incrementally updated and enhanced with the specific modules required. Complete computer systems will rarely be replaced. Modules will often be replaced, however, and plug-compatible, specialized modules will be offered by small vendors. The significance of these 1990 mainframes to the industry's competitive structure has yet to be determined, but it appears that as many doors will be opened as are closed. ◉

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Datamation 1/1/85

A new, cohesive integrated architecture is expected to emerge within the next five years.

IBM: MAINFRAMES IN 1990

by Norman Weizer and Frederic Withington

COLLAGE BY MARK YANKUS

This forecast is based on an analysis of three factors: the needs of IBM's large customers; the potentials of technology, particularly the kinds most familiar to IBM; and IBM's self-interest. Although the forecast is unlikely to be correct in every detail, we believe its overall direction is accurate.

By 1990, IBM will have evolved an integrated architecture encompassing all its multiple product lines. This architecture will be based on the following components:

- the SNA overall communications architecture,
- the DCA document content architecture,
- the DIA document interchange architecture, and
- office and factory-floor local area communications architectures.

These integrated architectures will operate under an evolving MVS/XA umbrella with VM/CMS playing an important role for interfacing end users. According to its Feb. 23, 1984 guideline statement, IBM does not intend to implement these facilities in DOS/VSE. Therefore, by 1990 we expect DOS/VSE will have been stabilized and its use will be declining.

As the primary host operating system, MVS/XA is expected to be able to operate on mainframe systems composed of a variety of functional subsystems (see Fig. 1). The stabilized versions of DOS/VSE and the then-current version of VM/XA will thus remain operable as job entry subsystem (JES) or application processors under MVS/XA. The IBM modular mainframes will also permit IBM processors with older architectures to operate as subsystems. This will be especially useful for customers who resist conversion to the new architecture systems.

Within this overall architectural framework, DISOSS will be the primary subsystem for all document filing, search, retrieval, and output functions. While initially text-oriented, DISOSS is expected to evolve to have a full spectrum of integrated

...will be able to choose degrees of increased cost ...obtain increased levels of fault tolerance.

storage and retrieval capabilities, including ones for image, graphics, and voice (both limited voice recognition and speech synthesis). DISOSS is expected to provide compatible, revisable form document storage and interchange facilities for all of IBM's office automation systems.

PROFS will continue to evolve (under DISOSS) as an easy-to-use end-user subsystem in the evolved VM/XA environment. Its functions will be enhanced to encompass full revisable text interchange among the IBM multifunction workstations, as well as enhanced forms of the professional office automation functions it currently supports.

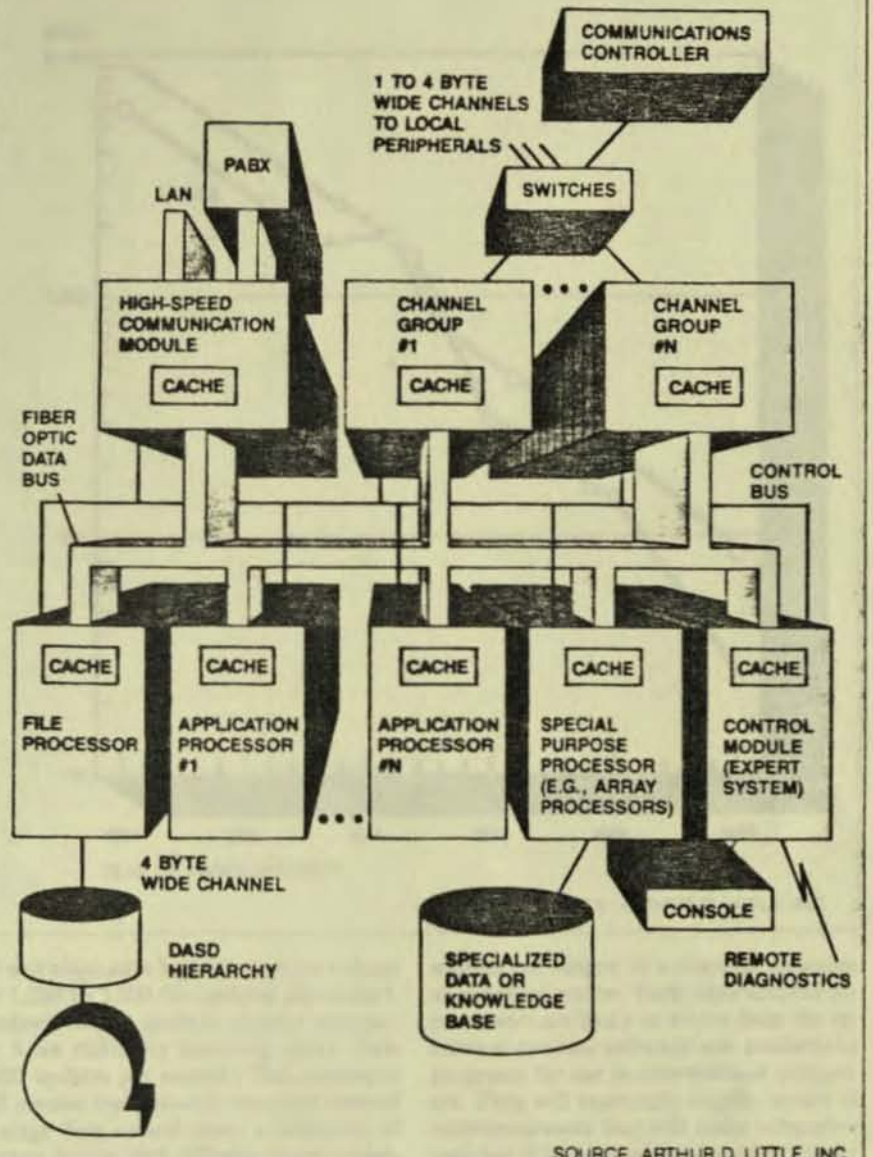
IBM's 1990 mainframe, then, will still play a central role in its overall architecture. It will be the central file manager and switch not only for data, but for objects in other media, and will of course retain its original role as a large scale batch and interactive processor when job sizes exceed the capabilities of network nodes.

By 1990, the electronic components available to IBM for use in its mainframes will cost no more than one tenth of current prices. Semiconductor memory chips, the largest of which now store 262,000 bits of information, will by then be storing 1 million to 4 million bits in the same area at about the same cost.

The cost of logic will also be lower. The 16-bit microprocessors now used in most personal computers have just passed the $10 price level; by 1993, they should be approaching $1 each. Similarly, 32-bit microprocessors with approximately four times the computing power will have dropped below the $10 level and will continue downward. These will be widely used throughout IBM's mainframes, and the still-needed higher-speed logic chips will also cost less.

FIG 1

IBM 1990 MAINFRAME HARDWARE ARCHITECTURE



SOURCE: ARTHUR D. LITTLE, INC.

SPEED MAY IMPROVE FIVEFOLD

Speed may prove to be somewhat more of a constraint. Faster circuits require denser packing of circuit functions on the microchips, an arrangement that creates problems of signal strength, heat dissipation, and quality control. Gallium arsenide should be available as a substrate, however, together with smaller feature size and better cooling for silicon chips. We expect about a fivefold improvement in the speeds of the fastest routinely available electronics, and even higher performance with new technologies.

To take advantage of the low-cost but relatively low-speed components that will be available, IBM's mainframe system of 1990 will contain multiple processors dedicated to specific functions. Each processor will contain a very large cache (in excess of 1MB) that will in effect be a loosely coupled main storage facility. The specific function of each processor, e.g., the instruction set to be processed, will usually be determined by alterable microcode. The processors will communicate with one another via messages and data blocks in standard form, regardless of whether the content is a program, data, digitized text, image, or voice. The processors will also be able to back one another up, should any one of them fail (fail-safe). Fault tolerance will be available both at the system level and at the device and component level to accommodate the increasing demands of users for high system availability. Users will be able to choose degrees of increased cost to obtain increased levels of fault tolerance.

The largest mainframe models will be capable of supporting up to 16 general purpose processors as well as several special purpose processors. Smaller members of the mainframe product line will be able to support fewer and less capable processing subsystems.

...istive searches of large databases will be ...ctical for the first time.

This mainframe-federated functional subsystem architecture will employ a fiber optic main data bus to interconnect the various functional elements, and probably a separate control bus.

Among the various optional functional subsystems offered in the product line will be

- several sizes of input-output processors,
- relational database processors and buffered file processors,
- application processors (for various programming language environments),
- array processor modules,
- image processors, and
- expert system modules.

Many of these modules will have hardware architectures specific to their intended tasks. Others will be software/microcode variants of the standard processing modules.

The input-output processors' sizes and characteristics will vary, including the capabilities of conventional channel groups and also new high-speed communication controllers. Among them they will be capable of communicating with several kinds of attached communications facilities and of switching messages between terminals (whether they contain data, text, digitized images, or voice). They will also control local batch input-output devices such as line printers, and existing DASD controllers if file processors are not used.

The application processors will be dedicated to particular computational environments. Some will be oriented to direct execution of programs written in specific programming languages (for example, COBOL or FORTRAN), while others will support problem-oriented languages (for simulation). Still others will run the software of obsolete machines. The orientation of each application processor will be specified by alterable microcode; within limits, the processor orientations can be changed via the supervisory processor to meet different workload requirements.

The database and file processors will evolve especially rapidly, based on evolution of the cache disk controllers (3880-21 and 23) and on hardware to support processing of relational databases.

SPECIAL PROCESSOR VERSIONS

Also available for different kinds of applications will be specialized versions of file processors. Text, voice, and graphic data will be stored in the same databases as computational data, with unique query, search, and report generation routines to account for the special characteristics of the data processed.

One type of specialized file processor will emphasize high throughput to handle 1,000 to 5,000 file updates per second. (Today's largest general purpose computers have difficulty handling more than 1,000 updates per second.) This processor will involve sophisticated computer control to stage data up and down a hierarchy of storage devices with different access speeds (in accordance with patterns of use), and to handle a variety of storage devices arranged in parallel for simultaneous access. Such high-throughput storage systems will be useful in centers with the largest processing networks.

Other types of file processors will employ less structured methodologies so that associative or content-related inquiries can be made. These less structured file processors will be useful in office applications or research and information-retrieval applications. They will be useful in collecting and retrieving a variety of text and graphic materials, as well as data from a number of sources not subject to a common structure or indexing system. Such unstructured file processors are likely to evolve from the relational database software now available as programs for use in conventional computers. They will eventually employ arrays of microprocessors that will make exhaustive searches of large databases practical for the first time.

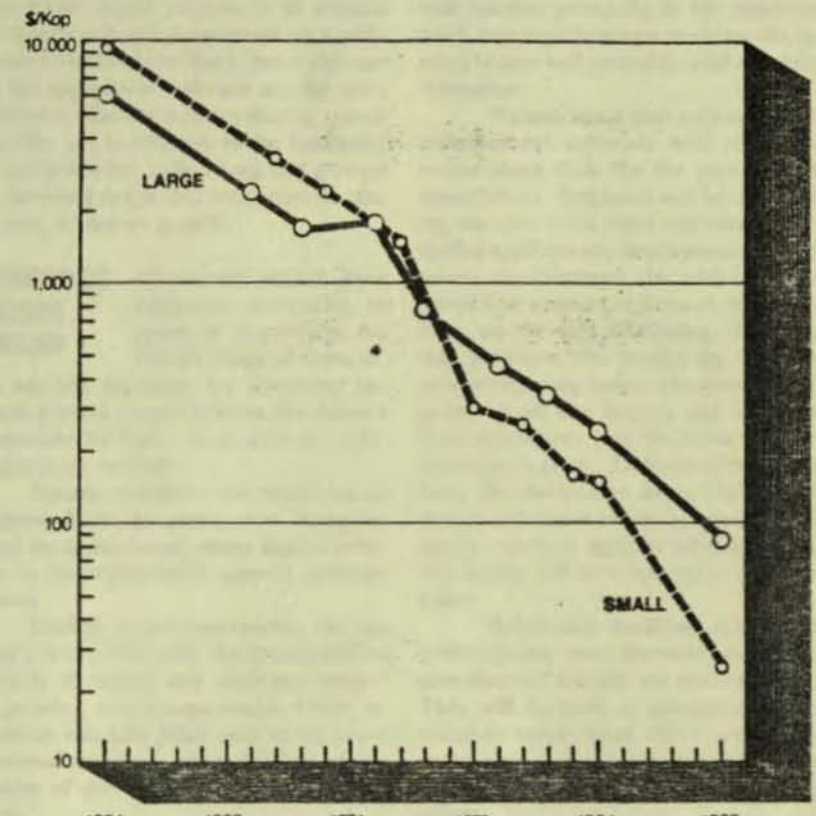
Other versions of file processing systems are possible for such things as voice or graphic information (which may be stored in noncoded forms). In the late 1980s and early 1990s, some processors will have special architectures adapted for artificial intelligence and/or data-driven applications.

In 1990, IBM will offer a broad family of these modular systems. This family will be headed by a tightly coupled confederation of very high speed general and special purpose processors with an aggregate processing power of over 100MIPS; the low end will extend down to workstations with

FIG. 2

IBM: HISTORICAL PRICE PERFORMANCE

LARGE VS. SMALL MAINFRAMES



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processing power of approximately 1 MIPS.

As shown in Fig. 2, IBM's current mainframe product line is characterized by two distinct price/performance levels. At the low end (4300), the systems average approximately $150/KIPS (one thousandth MIPS). At the high end (308X), the systems average approximately $250/KIPS. According to these price/performance trends, we project that in 1990, the low-end systems will be priced at approximately $20/KIPS and the high end at approximately $80/KIPS. The small systems pricing advantage will primarily be due to the lower performance components needed at the low end of the mainframe line, and the higher level of manufacturing automation that can be applied to production of smaller systems.

These prices are exclusive of separately priced system programs. By 1990, most IBM mainframe users will likely pay more on a life cycle basis for system programs than they do for hardware.

MVS/XA will form the primary system software environment for IBM mainframes in 1990. The current MVS/XA product will, however, be significantly modified between now and then. Most of the changes will take the form of additional and enhanced capabilities. IBM will be careful to change the existing program and JCL interfaces as little as possible to minimize customer compatibility and migration problems.

We expect the major MVS enhancements to include

- the addition of more functional subsystem capabilities,
- the addition of autonomous monitors to operate the various functional subsystems,
- the migration of increased amounts of code into the microcode of the various functional subsystems.

These enhancements will be needed because the operating systems accompanying modular computers must also become modular. Already, MVS/XA is undergoing a long-term, gradual transition from an easily identified, integrated collection of software to modular software and microcode-implemented sets of elementary functions whose major purpose is to allocate and control subsystem resources on a millisecond-by-millisecond basis. Since the user and his application software are far more sensitive to changes in the operating system than they are to changes in the hardware, this transition has to be a long and gradual one, avoiding major discontinuities or conversions, whenever possible.

MICROCODE ASSISTS A TREND

Microcode assists have appeared primarily to speed up processing. Although many of these assists are not necessary for operating the system, a trend toward making the assists a prerequisite for higher-level software is becoming more marked.

System interfaces are beginning to disappear from the user's view, being replaced by easier-to-use, more logical interfaces in the higher-level support software systems.

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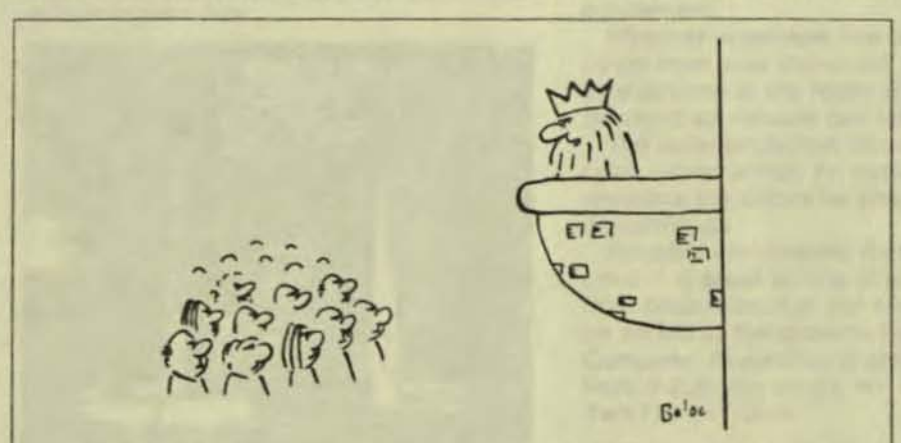

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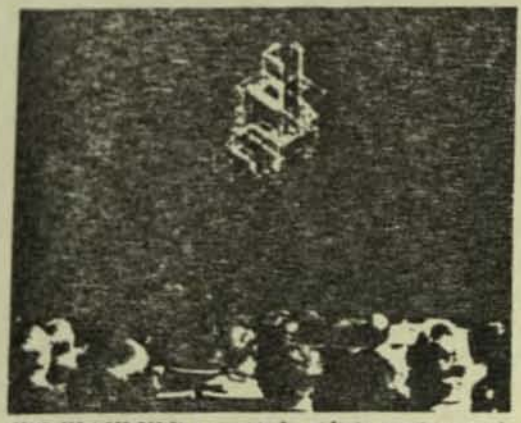
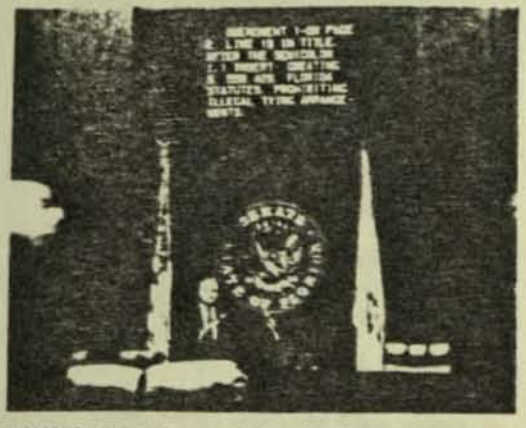


COMPUTER-AIDED DESIGN displayed by General Electric projector is viewed by Engineering Society of Detroit.



WORDS PUNCHED UP by clerk of Florida State Senate are inspected carefully before a vote

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IBM's Soothing Balm

The computer giant's biggest customers face a transaction processing software bottleneck and some agonizing choices. Does IBM have an answer?

by R. Emmett Carlyle

A new operating system designed specifically for on-line transaction processing (OLTP) is in the early stages of creation at IBM. Details of the new MVS-compatible program were leaked recently to a handful of worried MIS executives at major accounts. They have been pressing IBM for an integrated, high-performance solution to on-line processing.

"The development is more of a statement of direction at this point," says one New York dp executive who requested anonymity, "but it does help with forward planning, and offers clues to the systems software that will be offered with IBM's next mainframe family, Summit."

IBM may also want to place some of its renowned FUD (fear, uncertainty, and doubt) in the hearts of users considering the decentralized approach of its arch-rival Tandem Computers, Cupertino, Calif., or of Aspen, the IBM-compatible operating system for OLTP that Amdahl Corp., Sunnyvale, Calif., is developing.

IBM's new operating system will be a "composite," as one observer puts it, of all its existing and incompatible OLTP software and its premier database manager, IMS. Merged together with IMS will be IBM's teleprocessing standard, CICS, and its revamped and renamed Airline Control Program, TPF2 (for Transaction Processing Facility, Version 2). The new composite OS is projected to handle concurrent updates to the database, while MVS, in background, handles batch, general utilities, and services, sources say.

"Vital portions of the new operating system will be implemented in microcode [instructions placed in Summit when it is built]," adds another source, "and will receive considerable hardware assists." The first Summit machines, with 100MIPS and 512MB main memory, will probably ship in four years. "But IBM told me that the new operating system won't surface for another five years," this source says. IBM declines to comment.

Technical experts at customer sites were skeptical when asked if IBM could complete the project. Many believe that unstable code can be removed from IMS and its performance improved by new hardware—some say to beyond 4,000 transactions per second by 1990—but they claim the incompatibilities between IMS, CICS, and TPF will prove too much for IBM. In recent years, the giant has embarked on a number of ambitious software ventures, many of which—including a merger of IMS and DB2, called IMS2 or Eagle—were costly failures.

"It could be just another kludge," states one MIS executive in the banking sector, "but what else is there?"

The majority of transaction processing applications today are being implemented with large-scale IBM mainframes using IMS and CICS, but those aging flagships are being stretched to the breaking point by the emerging on-line financial services industry. Before deregulation fueled the fires of this intensely competitive young industry, IMS and CICS were seen by their devotees as panaceas. Now, because of inadequate transaction throughput (IMS/CICS typically delivers, users say, 30 transactions per second), they have become bottlenecks. If you stretch them to get more tps, they break, as crashes of IMS/Fastpath at Lloyds Bank of London recently demonstrated, according to London press reports.

IMS and its extensions, IMS/DC and IMS/Fastpath, typically can handle 60tps and 80tps, respectively. Yet, such peak loads as 100tps could be commonplace at the largest sites next year, placing the IBM products, at least some of the time, outside this realm. "The financial services market will demand around 200tps peak in two years," says a vice president at Citicorp, the New York banking giant. A number of large IBM customers such as airlines, banks, and other financial institutions, already foresee a need for 1,000tps in less than five years. "We're wondering how we'll cope—just like everybody else," sighs Al Crawford, senior vice president of payment systems at American Express.

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IBM's customers currently face an agonizing choice. TPF is capable of handling great transaction rates because it is not burdened by an underlying database management system—its file structures are relatively simple. As a result, TPF users must sacrifice functionality, because they have fewer choices of file types and access methods and, sometimes, data integrity. With IMS-based teleprocessing monitors, users explain, functionality is increased but transaction throughput is sacrificed.

Complicating matters is the fact that the TPF operating system and IMS/CICS are incompatible with each other, forcing users into an expensive migration or total rewrite of their programs. It seems that IBM customers can't have it both ways—an integrated solution offering high performance—until the new composite system appears. "Unless, that is, you look outside IBM for your OLTP system," says Barry Young, vice president of retail banking MIS at Wells Fargo Bank in San Francisco.

Wells Fargo and other IBM shops have been swayed by Tandem's pitch that you can have it all now, with fault tolerance thrown in for good measure. The $600 million-plus concern has been biting into IBM's mainframe sales with its NonStop hardware, and has implemented a number of integrated, on-line teller systems. Still, the big breakthrough orders have eluded Tandem because of its inability to convince IBM's biggest customers that its GUARDIAN/EXPAND computer cluster can be increased in an almost linear manner to 1,000tps, and beyond. Clever IBM marketing has played on its customers' reluctance to embrace non-370 solutions.

Tandem's vice president of software development, Dennis McEvoy, admits, "We're viewed as unconventional by the IBM mainframer mindset. But that's changing. The idea that the MIS manager always makes the safe decision, IBM, is a misperception.

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"The 3090 [Sierra] and TPF combination is too centralized and too low level to react to changes in the business environment. And we believe the MIS manager's first loyalty is now to his business, not IBM."

Early this year, JC Penney decided to take a chance on Tandem after an internal demonstration showed that 32 Tandem TXP processors linked over its FOX fiber-optic network could process upwards of 150tps. The demo, which resulted in a $10 million deal, was for a credit authorization network linking 40,000 POS terminals in 1,700 stores. After an evaluation of IBM's Sierra running TPF, JC Penney decided to go with Tandem's offering instead. In addition, sources claim that following the Tandem benchmark, JC Penney canceled a previous separate order for a 3090 Model 400.

John Dratch, director of dp and technical support at JC Penney in New York, says that since the Tandem network was not yet live, it was "an inopportune time to comment." Dratch perhaps uncomfortably aware of his shop's status as guinea pig for Tandem's architectural concepts, also preferred not to discuss a "meganetwork" of hundreds of Tandem computers that is being assembled for test during the middle of next year. Sources claim that network will deliver processing rates of up to 1,000tps.

Dratch also wouldn't say whether the company would have a place for the new IBM operating system. The JC Penney executive does stress that Tandem at last provides a real choice for IBM's customers. "There isn't only TPF for the foreseeable future," he comments.

That might not prove to be the case for the bulk of IBM's customers. It's a measure of their desperation that they are prepared to pay a one-time charge of $500,000 and a monthly license fee of $50,000 for TPF, a program developed for airline reservations. Even more staggering, users point out, is that the program requires legions of highly trained and well-paid assembly language programmers to keep it humming. Despite these shortcomings, IBM's customers have flocked to the product. Industry sources claim that the two-year-old TPF2 now has 100 customers, though IBM declines to confirm this.

"No other IBM solution, so far, can deliver transaction throughput in excess of 100tps," says American Express's Crawford, himself a user of TPF. "But with only the beginnings of a rudimentary DBMS, data integrity can't be guaranteed, as with IMS-based systems. In addition, TPF's centralized, low-level approach seems like a labor-intensive, backward step in this age of user friendliness and fourth generation languages. Since system services and new applications have to be developed in assembly language—without the benefits of fourth-generation language tools—they are developed very slowly, and are difficult to maintain.

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TANDEMCOMPUTERS

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At Bank of America, San Francisco, which is ploughing millions of dollars into the creation of a TPF-based automated teller machine network, one source says there is some hope. "A team at American Airlines' data center in Tulsa, Okla., is developing some 4GL productivity tools for TPF—screen painters, report writers, and the like—that we may buy." Officials at the bank and the airline were unavailable for comment at press time.

"Even with the tools, we don't now believe that TPF is the complete cure-all we once thought it was," says the bank source, who adds that Bank of America was exploring other technology for non-ATM applications.

"We feel that TPF2 is adequate for the next two or three years," says American Express's Crawford, "and then we'll see." He notes that the charge card giant has strategic planning groups looking at multicomputer and parallel processing solutions for OLTP. "And we're looking at fault tolerance," he adds.

IBM, though betting on TPF and Sierra, has been filling the holes in its product line that Tandem's thrust has exposed. The computer giant is now marketing the fault tolerant computer of Tandem's biggest rival, Stratus Computer of Natick, Mass. IBM may be planning to manufacture the Stratus product, which it sells as the System/88, and perhaps sell it for data communications applications in lieu of its aging 8100 and Series/1 machines. It is still unclear at this point whether IBM is developing improved SNA software links for the Stratus systems, which currently offer only 3270 emulation.

IBM, of course, is not all-seeing and all knowing. Its planners do not always have the necessary blend of business and technology backgrounds. So, as usual, the company is throwing research at its problems, and pursuing a number of directions in parallel. At least three fault tolerant, multicomputer schemes have originated at its San Jose and Yorktown Heights, N.Y., research centers. The most likely to survive to the marketing stage, say sources, is a cluster based on "baby" 4300s.

For the present, at least, IBM is telling customers to be patient. An integrated OLTP solution is down the road, and new Sierra hardware is at hand to squeeze more performance out of systems software. This is IBM's traditional soothing balm: "If you've got a performance problem, throw more hardware at it."

"Some IBM customers believe that all they have to do is ride the Sierra technology curve and IMS performance will be greatly improved by the hardware of upcoming models," comments Omri Serlin, head of ITOM International, a consulting firm in Los Altos, Calif. "Maybe they're right. Since the market for OLTP is exploding in an unpredictable manner, the issue isn't cut-and-dried either way."

The Coming Computer Industry Shakeout

Winners, Losers, and Survivors

STEPHEN T. McCLELLAN

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get it right. There is no way a generalist firm can stretch its resources so thinly and remain an effective competitor (only IBM has been effective in doing this). In today's market, the company that tries to cover more than a few hot niches is doomed to failure.

The young, insurgent specialty companies do not suffer from such problems. Small and voracious, they are able to concentrate their energy and resources—marketing, management, R&D, finances—on small product lines and attack the industry like piranhas. They enjoy the advantages of leading-edge products, specialized sales forces, higher profit margins, and accelerated growth.

The first of the insurgent specialty companies are now established leaders in their respective niches. Digital Equipment, Hewlett-Packard, Storage Technology, and Wang Laboratories rode the minicomputer, peripherals, and office automation booms. All four are among the top 12 companies in the industry, with sales of over $1 billion each. They have experienced combined revenue gains that are triple those of the non-IBM mainframe companies over the past decade.

Waiting in the wings is another echelon that has already passed the half billion mark in sales: Apple Computer, the Camelot company; Data General in minicomputers; Tandem Computers, the leader in fail-safe computers; and ROLM, one of AT&T's big competitors in the market for automated switchboards. And there are others—some on the rise, some on the decline.

Then there are countless baby insurgents, if one considers $50 to $500 million in sales to be the equivalent of infancy in the computer business. This is a diverse group that includes Convergent Technologies, Apollo Computer, Commodore International, Cray Research, Diebold, Tandon, and Verbatim, to name a few. It is from among the ranks of these type of insurgents that a new leading order in the industry is taking shape.

THE COMING IMPLOSION

Although they are riding high now, the future of these specialist companies is by no means a sure thing. Already some of them show signs of not keeping the pace. Digital Equipment is in a difficult

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of the Federal Communications Commission (provided in the 1981 decision known as Computer Inquiry No. II), AT&T is now permitted to enter the unregulated business of providing computer hardware and services. AT&T's debut has not been an auspicious one. The company seems to be concentrating first on making up for lost ground. Because it has given up a good chunk of its telecommunications equipment market to such competitors as ROLM and Northern Telecom, it has to first win some of that back before it can make a thrust in computers. But an even bigger question has to do with the fact that AT&T has never had to compete in the open market before. Can a formerly regulated company change its stripes?

Japan is the most controversial new competitor. Concern that Japanese companies will take over the computer industry the way they did automobiles and consumer electronics is a commonly voiced fear. Yet, there is really no reason to worry. Computer technology, products, and markets are changing so fast, accelerating to such a degree, that the Japanese will have trouble getting a foothold. The Japanese threat will remain just that: more a threat than an inroad, at least until the computer business matures.

Japanese influence will be felt the most in inexpensive, low-value-added products, such as personal computers, printers, terminals, and semiconductors. They are at a disadvantage providing more sophisticated kinds of computing, where software, systems integration, service, and marketing are more important. The computer industry may still be moving too fast for the Japanese to catch up. Yet, the Japanese influence on U.S. computer manufacturers may be telling. The mere threat of Japanese penetration will push U.S. computer companies to concentrate on quality, strive for low-cost production, pursue creative and varied marketing channels, and provide services equivalent to none other than IBM.

If any of these companies (or countries) can't cut the mustard, there are always others ready to take their place. ROLM, especially with its new alliance with IBM, could well be a competitor through its computerized telephone switchboards (or PBXs), which are capable of handling both voice and data. And then there is Tandem Computer, the inventor of one of the most novel but eagerly accepted computer systems: a fail-safe computer.

tinguishable commodity, selling, service, and software will separate the winners from the losers.

A second group of four critical factors is evident from the analysis of the industry contained in Chapter 2. A company must be *small* and *specialized* to be able to act quickly in a fast-changing and fragmented industry. And a new *style of management* is necessary which departs from the professional management techniques honed by the broad-based computer companies of the hardware era. A successful company will also need access to financial resources that will not place heavy demands for repayment of interest expense during periods when the company might be experiencing a slowdown. *Stock financing* has this advantage over debt.

Finally, any company that hopes to survive and compete over the long haul will have to sell more than discrete computer products. It will have to offer *systems compatibility*. The features that now sell a computer product, such as the amount of memory or the speed of the processing unit, will become secondary to whether or not the product can share data and communicate with other equipment. As the computer industry fragments and new products blitz customers from all directions, systems compatibility, probably IBM compatibility, will be a prerequisite. A machine will not stand alone, out in the cold, unable to tie into other machines.

SELLING

Marketing is king in the computer industry—and it is going to stay that way. Since the 1950s, the army of dark-suited, white-shirted, IBM salespeople has been the major reason for the predominance of that company. Not only IBM but many of the big winners, including Digital Equipment, Hewlett-Packard, and Wang, as well as such newcomers as Tandem Computers and Tandy Radio Shack, owe a large measure of their success to the decision to create their own sales network.

A variety of marketing channels are being used extensively today, including dealers, distributors, and most recently retail stores where computers are sold like stereos. Yet the lessons learned by the big winners are more important than ever. In all but the mass consumer

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the personal computer and compatible data terminal companies are discovering in the 1980s. Of course, once a specialty market is a proven success, IBM can swoop in for a landing, apply its enormous resources, and capture a significant share of the market. Even for IBM, however, large size is a problem, but one that it appears to be managing quite well. To obtain the benefits of smallness within bigness, IBM has established several independent business units (IBUs), free of corporate and bureaucratic overhead, to tackle such specialty niches as personal computers, software, robotics, and CAD/CAM (computer-aided design/computer-aided manufacturing.) Even for a giant such as IBM, small is beautiful.

STYLE OF MANAGEMENT

The management style of the small, specialist computer company of today's industry is altogether different from that of the larger, broader based computer companies of years past. The key to this new style is the preservation of an entrepreneurial atmosphere that animates the organization from top to bottom. Small size makes it possible for such an atmosphere to flourish. A small firm permits formal and informal lines of communication to operate side by side and does not encourage the formal regimented procedures that are the inevitable accompaniment to growth. Individual accomplishment is more easily recognized. Office politics, while inevitable anywhere, can be kept to a minimum.

But small size is not in itself enough to create an entrepreneurial atmosphere. It is up to management first to plant the seed. Leadership by the founders seems essential. When management has an individual style, whether it is fun and colorful or the underdog on the hustle, it rubs off on the employees. Team spirit, enthusiasm, common goals, and a feeling of identity are all encouraged. Management really has to care about its people and show an interest—to have beer busts, sabbaticals, company nautilus equipment, and a pool. A creative nonconformist at the top means there is room for the same throughout the ranks. In theory, this air of creativity can be instilled by professional management, but this rarely happens. In almost every successful specialist computer company, its pioneer and founder is active in its affairs: Kenneth H. Olsen at

Digital Equipment (minicomputers), An Wang at Wang Laboratories (office automation), H. Ross Perot at Electronic Data Systems (data services), James H. Treybig at Tandem Computers (fault-tolerant computers), Jugi Tandon at Tandon (floppy disk drives), and John J. Cullinane at Cullinet (database software).

Preservation of an entrepreneurial atmosphere requires a delicate balancing act. A manager must be able to rein in the egocentric energies that founded the company in the first place and apply them to the more mundane tasks of managing the company's growth. Assuming the company has reached the point where it can go public, management must be able to withstand investor pressure for short-term results and make the sacrifices necessary to ensure survival over the long haul. Finally, management must be able to instill the discipline needed to withstand the upturns and downturns that are part of a cyclical economy, while still allowing an atmosphere conducive to creativity.

Ultimately, however, the most profound demand on management will occur as the computer industry continues to shift away from hardware toward software. Traditional management techniques that were developed during the industrial era are proving inadequate. The most successful companies will be those where management is able to make the adjustment to the fast-paced changes wrought by developments in microprocessors as well as the new era of software development. Management in the information society requires a new set of rules. The successful managers of the information companies themselves will be the first to write them, as the president of Intel, Andrew S. Grove, has done in his book *High Output Management.**

STOCK FINANCING

It takes a lot of money to start a computer company and keep it going. Those who try to do it on a shoestring usually end up tripping over themselves. The way in which capital is raised—equity versus debt financing—is as important as the amount. Going public has

* Andrew S. Grove, *High Output Management* (New York: Random House, 1983).

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mathematician who played a prominent role in the early development of computer technology—is a simple, efficient design, but one that poses a great risk to the user. What happens when the processor (or any other part of the system) breaks down? Unless you happen to have another computer on standby—an expensive and unwieldy safety precaution—you are out of luck. In the early days of batch processing, when computers were given work one batch at a time to complete before the next batch, such breakdowns, albeit annoying, were not as pressing a concern as they are in today's environment of continuous interactive, on-line processing. A computer system with a multiprocessor or parallel processing architecture is becoming essential in many organizations (such as banks, airlines, and stock exchanges) that depend on computers to perform customer transactions around-the-clock. Multiprocessor architecture also opens the way toward major improvements in computer performance that can be likened to the greater power of an automobile engine with dual carburetors.

Tandem was the first of the new-wave hardware companies with its line of dual-processor, nonstop computers. At a time when most computer hardware was being reduced to a commodity-like existence, Tandem outfoxed the market with a radically new hardware design that users desperately wanted (although, as we shall see, software plays a great role in it). Tandem revenues went from virtually zero in 1976 to $450 million in 1983. It is so far ahead of the market that, after 8 years, it is still without significant competition, although that situation is now changing. Tandem will not be alone for long.

Another key aspect of the new computer architecture is flexible modular design. In the past, a computer system was judged on the number of terminals it could support at any one time—1, 2, 4, 16, 32, and so on. The new wave of hardware will be judged on how many actual computers (not terminals) can be linked in networks, sharing processor power, software programs, data, and images with one another, and on the ease with which this sharing can take place. In Tandem's current system, thousands of Tandem computers can be connected in a network covering as many as 255 geographic locations. This networking capability is the main selling point of the most successful of the new office computer and work station

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companies, Convergent Technologies and Apollo. They have networking as a standard feature. In the coming era of systems integration, this capability will be a feature without which no computer company can hope to survive.

Of course, these advances in computer architecture would have been impossible without the major increases in microprocessor performance—advances that show no sign of abating. Microprocessor chips are available from Intel (the 86 series) and Motorola (the 68000 series) that can be configured so as to equal in power, at under one-tenth the cost, the Digital Equipment VAX-11/780 superminicomputer that was introduced in 1978. New microprocessor chips, created through a process known as complimentary metal oxide semiconductor (CMOS, for short), will have 30,000 to 50,000 gates. Older chips, based on emitter-coupled logic (ECL) or transistor-to-transistor logic (TTL), are capable of only 2000 gates per chip. Vast improvements in performance are also possible because of a microprocessor operating system, UNIX, which is rapidly becoming an industry standard (even IBM may soon announce UNIX availability across all product lines). UNIX will be the standard and will take a major role in this new-wave supermicro phenomenon.

For the old-line minicomputer companies already battered by personal computers, these new-wave start-ups are another unwelcome development. There is no way such companies as Digital Equipment, Data General, or Hewlett-Packard can ever hope to compete with these upstarts. They are too committed to past computer hardware design architectures, and the myriad software programs developed for the existing products. To change now to a whole new line of incompatible equipment would be devastating to their customers who use current products and software. They could not upgrade to the new products. In short, these companies cannot participate fully in the microprocessor era. To remain compatible with their old product lines and at the same time try to come up with new performance standards they would have to create expensive, custom-made chips, and even then the performance of their computers will be no match for the new-wave architectures. It's a double-bind: new chips and new architectures.

The old-school companies are constrained not only technologi-

cally but also by way of habit and practice. Engineers do things the traditional way. Thinking is narrow and unoriginal. Bureaucracy, hardening of the arteries, bloated organizational structure, decision by committees, loss of the creative entrepreneurial spirit—all this makes it more difficult and time consuming to get new products out of R&D.

With no obligation to the past, no inhibiting commitments, only the new wave has the freedom to take the industry in new directions. Small and entrepreneurial, they also have the energy it takes. This is the beginning of the new industry order. And already there are close to 100 such supermicro companies in the business. The list of start-ups is bulging: Sun Microsystems, Synapse, Stratus, and others. Who cares about the potentially troublesome hurdles still ahead—marketing difficulties, widespread customer confusion, the looming presence of IBM? That's all the more reason for the captains of this new industry order to take their companies public, make their millions, and then keep all options open for a possible quick exit. After all, that's part of the new order too, isn't it?

TANDEM COMPUTERS: THE NONSTOP WORLD OF JIM TREYBIG

Tandem can be summarized in one word: Treybig. Tandem's founder, James G. Treybig, is a colorful iconoclast, a guru, a radical thinker about computers and management who has created a company as unusual as his style. Tandem had over $400 million in sales in 1983, up from nothing in 1976. From six customers in 1977, the list has expanded to 758, with a total installed base of some 6,397 processors. Tandem's computers are no backwater, secondary product. They are critical to the on-line transaction processing of major banks, airlines, and telephone companies. And the customers know it. Customer loyalty is the highest in the industry, above even IBM.

What makes Tandem run? For openers, the product—the NonStop computer. It never stops. That is the very basis of its design and

function. In a Tandem system, two or more processors operate in parallel as an interactive network. If one processor fails, the rest of the system keeps running. This multiple computer architecture not only minimizes the risk of system failure but also protects the data from being damaged or destroyed. Because of its unique design, it is easy to add more computer processors to the network. Originally, a single Tandem system could operate with 16 processors. By 1979, with the introduction of EXPAND software, up to 4080 computers could be attached in as many as 255 different locations.

The key to Tandem NonStop computers is software—extensive, complicated, sophisticated software that allows the computers to work together, yet also work around any unit that may have failed. The software includes an operating system, database manipulation programs, database inquiry and report writing programs, program development aids, communications software, and the like. Established mainframe and minicomputer manufacturers cannot duplicate Tandem's fault-tolerant computer systems. It involves more than just hooking a few extra processors together. It requires all new architecture and software.

Almost as important as the product strategy at Tandem is the management style and leadership of Jim Treybig. Treybig's Texas drawl and self-assuredness, combined with his sincere care for and trust in his employees, is renowned in Silicon Valley. This is where people-oriented, California-style, high-tech management culture all started. Treybig is both the gospel and the keeper of the creed. Everything, from product shipment schedules to employee lifestyles, figures into his management philosophy. Tandem may be the closest company yet to creating a truly democratic atmosphere. Everyone benefits from the company's success more or less equally. Treybig's office is no different from that of the lowest-paid programmer—small and unassuming. There is an atmosphere of trust at Tandem. Everyone is in it together. All understand the essence of the business. Friday afternoon beer busts include everyone from the president to the plant janitor. Everyone communicates, from the highest to the lowest level, allowing cross-pollination. Every employee gets a 6-week sabbatical after 4 years of employment. Recreation facilities include a pool as well as volleyball and basketball courts. Single parents, prevalent in the high-tech country

of California, bring their kids over on the weekends and grab a few hours in the office while their offspring splash around. Treybig pays attention to his people and reaps the benefits: Productivity rises. And Treybig fights for creativity, to preserve the small-company atmosphere. Tandem has the most sophisticated company-wide electronic mail system of any of the 40 computer companies I visited for this book. And it is used. Some 4000 employees can query the boss from as far away as Kowloon, Hong Kong, by merely hitting a few keys. Tandem is different. It is almost a cult.

Looking to the future, Tandem faces a number of challenges. Despite the happy atmosphere, there has been management turnover at the top. Three of the four founders (all but Treybig) have departed. Many early members of management, after they cleaned up financially with the stock they held, lost the will to work at the torrid pace and left. As Tandem gets larger, heading toward the $1 billion level, it will be difficult to retain the small-company creative atmosphere. Growth slowed to 35% in 1983 after almost doubling in every prior year. The company pushed growth too hard during the recession, at an unsustainable rate, and incurred accounting restatement problems once it discovered some business was booked prematurely. After that, it had to tighten up its financial controls and procedures, sacrificing some freedom and decentralized authority. Some competitive newcomers on the horizon will use inexpensive microprocessors to provide computer redundancy, instead of the highly sophisticated hardware-software solution developed by Tandem. And Tandem, like other more traditional computer vendors, is now committed to its architecture and software, rendering it less flexible in this era of microprocessor technology. Its 16-bit design cannot easily be upgraded to 32-bit capability.

Tandem wants to eventually be one of the two or three surviving mainframe companies, reaching $1 billion in sales within a few years. Treybig believes a high-tech company must grow or it will be destroyed. Tandem is likely to flourish for a number of years. It will continue to make sizable inroads into the mainframe market, and competition will be minimal. Tandem's products are so necessary for computer users that demand for them will continue to be strong. And as long as Jim Treybig is still around, this company will hold together.

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THE BIG SCORE

The Billion-Dollar Story of Silicon Valley

MICHAEL S. MALONE

Doubleday & Company, Inc.
Garden City, New York
1985

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Probably the only way to get a handle on the systems industry is to divide its history (and its companies up) into technological eras.

The first systems industry was instruments. This industry enjoyed two great growth periods: from World War II until about 1960, and then again during the seventies. The first period featured analogue devices for the simple test and measurement of distinct functions, like the voltmeter or the audio oscillator, or, a more sophisticated product, the oscilloscope. The big Valley companies in this business were Hewlett-Packard, Varian and Sylvania.

The second jump in the instrument business, in the seventies, came with the rise of microprocessors. Now the instruments of the past could not only be made digital, which increased accuracy and the ability to manipulate the data, but they could also be given semiconductor intelligence to make operations more flexible and adjustable to changing needs. In addition, this "smart instrument" era was propelled by vast improvements in sensor technology, which led to an explosion in the analytical instrument business, with products such as gas analyzers, medical patient monitoring systems, ultrasound devices, X-ray tomography and industrial pollution "sniffers." The big Valley companies in these fields were: medicine—HP, Diasonics, Xonics; gas analyzers—HP; and process control—Acurex, Measurex. All of these businesses were hot markets in the 1970s and early 1980s . . . except at the end, when pollution control suffered the vagaries of the economy. It seems customers only worry about pollution when they are making money.

Computers had their first great era a decade before, in the 1960s. In the Valley, the chief participants were IBM's memory division in San Jose; Ampex and Memorex, with computer tape and disastrous forays into computing; HP with minicomputers; and Tymshare, which pioneered the concept of selling computer time to subscribers. Waiting in the wings at the end of the decade was the business of building large computers to run on IBM software, the attack to be led by Amdahl Corp.

(As you may have noticed, IBM has its hands over every corner of Valley life, to its victims seeming like some evil genius, a corporate Dr. Mabuse.)

It was in the 1970s that the local systems business, particularly its consumer wing, really took off. It began with the pocket calculator in 1973, followed quickly by the digital watch. At the time it seemed

though everyone and his brother was making one or both of these products: computer companies (HP), chip houses (Intel, Fairchild, National Semiconductor) and new start-ups (Litronix). But within two years it was all but over, the price-bombing marketing policies driving out or destroying every competitor in the business, before itself succumbing to Japanese competition. The Valley was littered with ruined consumer electronics companies and suddenly cash-poor chip houses. Only a bloodied HP remained in the business.

The consumer electronics crash came at the same time as the recession of 1974–75, putting a double whammy on the Valley. This was Silicon Valley's first great bust, but it hit the semiconductor houses the worst. The next one would belong to the systems companies.

Like all good high-tech recessions, the 1974–75 downturn was a time of great entrepreneurial activity. The conditions were right for new companies to be formed and get a running start in time for the next upturn. It was during this period that many of the firms for which Silicon Valley is now known got their start, either being founded or coming together as serious firms: Rolm (entering the telephone market), Apple, Amdahl (introducing its first product), Atari, Commodore (as a computer company), Shugart (in its second incarnation) and Tandem. It was these firms that would lead the resurgence of the late seventies in Silicon Valley, filling in the orchards and making the systems business the primary manufacturing activity there.

It started off slowly, with scores of little companies hidden away in rented rooms in industrial parks working out their product ideas, building prototypes, finding investment money. By 1978 and 1979, thanks to changes in capital gains taxes, the boom was on again, and these firms suddenly stepped into public view with fancy new offices and extensive ad campaigns. For the experienced Valley watcher, the hints had come a year or two before, with sudden departures of executives at established firms for parts unknown: they would appear a year or two later in some hot new start-up. Signs also came in the growing number of personnel advertisements in the back of the San Jose *Mercury-News*, a Valley economic barometer, followed by new product announcements in *Electronic News* by companies never heard of before, then product advertisements and technical articles in *Datamation* and *Electronics*—then *pow!* The Silicon Valley entrepreneurial boom was back on.

The development of the microprocessor and the general expansion of the semiconductor technology made this boom possible. It seemed (as it still does today) that the number of applications for this new

the carefully tended office and manufacturing areas, the friendliness of the employees matched by an equal reserve that indicated that Rolm people felt as though they were part of a team, and, most of all, an intense loyalty. These were the things that made Rolm another shining example of how a company can be both successful and oriented toward its employees.

In the early eighties, Rolm again began to change course, building on its existing expertise in telecommunications to jump into the office automation business. It was a clever strategy.

The company is still in the midst of that transition, which will take most of the eighties. The firm is also showing signs of maturity. The new, unbridled AT&T is not going to play with kid gloves anymore. Rolm got a taste of that in the first quarter of 1984, when a phone company employees strike kept Rolm's systems from going on line for three weeks—resulting in only a 7 percent increase in sales over the year before and a 64 percent drop in net income. Even perfect Rolm, it seemed, could be hurt by a changing market.

Still, there was ample evidence that the rest of the world saw Rolm's downturn as only a temporary setback in a long, ever climbing path. After all, in less than fifteen years the company had grown from seventy-five thousand dollars and a prune-drying shed to more than $500 million in sales and more than seven thousand employees scattered around the world. The stock market showed its faith in Rolm by giving its stock, even during the downturn, an extraordinary forty-three-to-one price–earnings ratio—which gave Rolm a market value of $1.6 billion.

But the best confirmation of Rolm's true value came in mid-1983, when IBM agreed to purchase nearly 4 million new shares of Rolm stock for about $230 million. IBM had done this once before, a few months earlier, with Intel—and it was considered an indication that America's largest technology company had anointed these two firms as the best in their fields, as future partners in the combined computer/chip/telecom market of the future, and was guaranteeing to back them. Just what IBM had in mind was a matter of considerable speculation—but by the end of the year, two IBM executives had been nominated to the Rolm board of directors.

That, it turned out, was only IBM's opening gambit. With AT&T newly trimmed and unleashed on the open market, Big Blue wanted more than just friendly telecommunications equipment. It wanted Rolm, lock, stock and volleyball net. So, in mid-1984, Rolm stopped

being a Silicon Valley firm and became merely another brick in the monolith of IBM.

In retrospect, if one complaint could have been leveled at Rolm it was that it was rather dull. A good place to play basketball maybe, but a little too straight. The only quirkiness in the company had been Richeson, who'd taken riches and retired to do volunteer work with Creative Initiatives, a religious and philosophical organization that advocated world peace and fellowship. This cult for professionals was a big hit among engineers in the mid-1970s and rainbow-colored "Bless Man" and "We are One" bumpers were sported all over the Valley. Now that was kinky, but once Richeson left, Rolm went back to button-down sobriety. Oshman just wasn't a hoot-and-holler type, and the company was so damn organized it seemed to have worked out all the interesting creases.

No wonder IBM bought it.

But across the valley, in Cupertino, the other Hewlett-Packard imitator had enough wrinkles for both firms. This was Tandem Computer, founded in 1974 by James Treybig, two technical people (James Katzman and Michael Green) and financial whiz John Loustanou—all of them from HP. There probably never was a more eccentric crew that ever started a Fortune 500 company. Cowboy Jimmy Treybig, with his easy-going manner and country drawl, seemed like a hayseed from Clarendon, Texas, come to Silicon Valley to teach them city slickers a lesson. Loustanou, on the other hand, was a figure out of Noël Coward drawing room comedy, the George Sanders of high tech.

Eccentricities aside, these guys were pros, and they built themselves a monster company. Treybig in particular was often underestimated. As one vice-president said, "a lot of people when they meet Jim for the first time think he's a bullshitter, just shuckin' and jivin'." That attitude was easy to understand when Treybig created his own version of the HP corporate philosophy:

—All people are good.
—People, workers, management and company are all the same thing.
—Every single person in a company must understand the essence of the business.
—Every company must benefit from the company's success.
—You must create an environment where all of the above can happen.

To read this blue-sky philosophy and then to meet Treybig, with his drawl and shirttails hanging out, was to find yourself questioning how Tandem could have been successful. A New York *Times* reporter was stunned when, after years of interviewing stiff company presidents, Treybig showed him some snapshots taken on a recent trip of a shirtless Jimmy T. (as Treybig is called), beer belly hanging out and swigging from a bottle of beer, and asked, "How about this one for the employee newsletter?"

But Treybig was dumb like a fox. Behind the country-boy persona was a driven, aggressive and extremely competent businessman with a Stanford M.B.A. and years of experience at TI and HP and in venture capital. So sharp was he, in fact, that the prediction he made in his 1974 business plan for Tandem's sales in 1979 was off by only $1 million. In other words he had, before the company was born, planned for sales to double every year to $56 million in 1979. This wasn't good planning, it was divination.

Treybig had first gotten the idea for Tandem after he left Hewlett-Packard in 1973 to join venture capital firm Kleiner, Perkins, Caufield, Byers in San Francisco. At HP, says Treybig, he first ran into customers, such as banks, that needed a computer that would never break down. "What I saw was that to get a system that wouldn't fail, customers were spending large amounts of money to modify the computers themselves."

With $1 million in Kleiner Perkins money, Treybig and his three partners founded Tandem in November 1974. Six years later the company broke $100 million in sales. That was just about as fast as a company could go.

The key was the product: a computer system that theoretically never broke down.

The solution Tandem found was a skillful combination of hardware and software. Two central processors operated redundantly and were linked through special software that switched control back and forth in the event that one of the processors broke down and needed to be repaired. As most computers were relatively reliable anyway, the chance of both processors breaking down at the same time was minute.

At least that's the way Tandem told it. Others, like industry analyst David Gold, suggested that the main reason people bought the Tandem computers was their fine software. "Fail-safe is just a great marketing and advertising ploy."

Either way, for its first six years in business, Tandem appeared to

operate in a market with no rivals—and the company seemed to grow like a monopoly. Between 1974 and 1982, the company just about doubled its sales every year, breaking $300 million in 1982.

Again, as with Rolm, it took an extraordinary corporate environment to maintain the kind of explosive growth that would have blown most companies apart. As with Rolm, the key for Tandem was a modified HP Way. Tandem became famous for its swimming pool and its Friday afternoon beer busts. Other HP programs Tandem adopted included flexible hours, pushing responsibility down through the ranks, promoting from within. Tandem also took ideas from elsewhere: it shared with Rolm the Intel concept of a sabbatical after several years of service.

But Tandem carried the process one step further—one step too far, according to some detractors. Treybig sometimes seemed almost obsessed with forming a new corporate gestalt at Tandem, creating a mandatory two-day course on the company philosophy and even a book called *Understanding Our Philosophy*. He dreamed aloud about building a Tandem University where employees could live their whole lives around the sense of community created by working at Tandem. In reaction to what he felt was too many meetings and too much paper work at HP, Treybig created at Tandem an atmosphere so casual that no formal meetings ever occurred.

Yet it worked. Tandem grew like crazy. Its turnover was one of the lowest in Silicon Valley. The press was entranced by the whole crazy mess, the Executive Hunk contests and the beer busts and all the twists in a company that seemed so disorganized but yet roared toward a billion dollars in annual sales. Only *Fortune* hit a negative note when it suggested that Treybig's people-oriented style was a little more cynical than it looked on the surface—a Californicated version of

> the so-called Hawthorne effect, an increase in productivity that appears to result from *any* new attention paid to employees' working conditions or amenities. Even the beer bust, in terms of the current fashion for fostering unstructured communication across an institution's vertical and horizontal boundaries, is arguably a productivity ploy.
>
> Also hardly novel is soaking employees in an endless stream of company-boosting propaganda urging loyalty, hard work, self-esteem, and respect for co-workers . . .

Undoubtedly, much of that was true. But so was the counterargument that Tandem's well-educated employees could see through any

overt attempts to manipulate them and would vote with their feet—which they hadn't done. Further, it was apparent that Treybig and his staff seemed to believe their own platitudes and lived them—so that if anyone was being manipulated it was the manipulators themselves.

There was a lot of talk about the efficacy of the Tandem corporate philosophy during the days when the firm was flying high. After all, one of the great Silicon Valley truths is that success covers up mistakes that failure throws into sharp relief.

That acid test came in 1982 and 1983. Suddenly Tandem, which had operated almost unmolested in its market, found itself under attack from every direction. Big guns like IBM and Digital Equipment announced high reliability computers. And the same time Tandem was attacked from below by a host of new start-ups, including two Valley firms, Tolerant Systems and Synapse, and most notably Stratus Inc. of Massachusetts, composed of ex-Tandem employees. Then Tandem suffered the embarrassment of having to restate and downgrade its 1982 results because it had improperly tallied orders that had not yet been shipped. The company's grow rate fell to "just" 50 percent. The slump continued into 1983. Tandem's stock at one point fell 45 percent and industry watchers questioned whether the company had finally grown beyond the control of its management style. Said David Gold, "That gunslinging management style doesn't seem to be working as well as it used to."

Treybig appeared to wonder about the same thing as he began to tighten the company's internal controls and turn the place into a more mainline firm. Observers waited to see if the funky Tandem style would survive.

* * *

In the beautiful Mark Hopkins Hotel, atop San Francisco's Nob Hill, the Western Association of Venture Capitalists—"the California Mafia"—meets monthly to talk shop and to hear presentations from politicians or the presidents of Silicon Valley firms the members control.

The setting is elegant, the conversation convivial. Nothing could be more at odds with the fiercely competitive and engineer-ascetic life-style of Silicon Valley, forty miles to the south. Yet this is the other, hidden, half of a symbiotic relationship that makes the Valley possible. Perhaps no tighter relationship exists in American industry than this one between electronic entrepreneurs and those crapshoot investors who not

only give them money and eventually take them public but hold their hands during the years in between.

Ever since the 1960s, West Coast venture capital firms have been closely tied with Silicon Valley firms, the success of each dependent upon the other. In those early days, only a few investors in the nation had the risk-taking attitude and the technological expertise needed to back a state-of-the-art electronics firm. Some were East Coasters who migrated west. Others were homegrown Valley executives who crossed over. These individuals cut their teeth in the early Silicon Valley wars.

Some individuals, such as Arthur Rock, Fred Adler and William "Pitch" Johnson, and such firms as Hambrecht & Quist and Kleiner, Perkins, Caufield & Byers, have become well known for their ability to spot young winners. But for the most part, it is an anonymous industry. Like all good bankers, venture capitalists tend to seek a low profile, keeping their names out of the newspapers, except of course for the tombstone ads announcing a company going public and on the 10K forms listing major company shareholders. It is also very democratic. The opinions of some venture capitalists are more highly respected than others, "But," says David L. Anderson, general partner of Sutter Hill Ventures, "I don't believe that because Kleiner-Perkins or the Mayfield Fund turns down somebody that everybody else will too."

It is this strange-bedfellows arrangement that has made Silicon Valley work. The frantic competition and wild-eyed self-aggrandizement of the electronics industry is countered by the collusive, genteel and invisible venture capital industry supporting it. But the nature of each industry makes those characteristics necessary. Silicon Valley must be competitive to survive, coming up with new innovative products and companies that can only be built by the aggressive, paranoid, maverick minds of entrepreneurs.

The members of the venture industry, on the other hand, need one another. Few can (or would) put up all the venture money or have all the technical expertise needed for a new start-up. So they create consortiums among themselves, swapping information at the monthly WAVC meetings or in the Sun Deck cafeteria at 3000 Sand Hill Road in Menlo Park, the home of more than a dozen venture capital firms and the center of the business on the West Coast.

Nevertheless, "you can't really call us a cabal because sometimes we work together and sometimes we compete," says Thomas Perkins, Kleiner-Perkins's general partner.

In the eighties, the venture capital industry has changed, a victim of

Printed By: NEPPLE_BARBARA @TSII
SENT: 86-10-03 11:29
FROM: TANGNEY_CACEY @CORPII
TO: TANGNEY_CACEY.BROADCAST @CORPII
SUBJECT: More on Customer Satisfaction

\poff 5
To: All Tandem

Fr: Cacey Tangney

Re: Customer Satisfaction

Dt: 3 October 1986

Even without the hundred MAIL messages I have received, I know everyone is interested and concerned about our decline in customer satisfaction in the Cowen/DATAMATION survey. In this message, I will provide more detail about the ranking and about the survey in general.

Earlier this week, Tandem attended the Cowen Conference where the results of the Cowen/DATAMATION survey were presented. Jim Treybig made a presentation to the conference (attended by nearly 300 institutional stock investors). While it was obviously negative that we fell in the customer satisfaction ranking, I would say that most of the qualitative comments made about Tandem during the survey presentation were positive. In addition, Jim's presentation was very well received. I have had several investors express an interest in investing in Tandem as a result of his speech. Our stock strengthened after his speech. (In contrast, Stratus' stock has fallen in response to Bill Foster's speech, in which he said they were behind their revenue plan.)

I will be contacting the people who conducted the survey to see if we can find out more about who was dissatisfied. If that information corresponds with the information we have gotten from our own surveys, we will be able to address the problems and regain our ranking next year.

Stratus naturally will use their number one ranking as much as they can. We can at least point out that the survey covered only 13 Stratus sites, which is not a statistically valid number. I also find it interesting that 1/3 of their respondents were OEMs or systems houses (which are primarily IBM and Olivetti), and that half their sites were organizations under $50 million.

\ov
Survey Description

The survey is U.S. only. The survey was conducted in July and August of 1986. 61,000 questionnaires were distributed to DATAMATION readers (limited to no more than 3 addressees per organization).

>74 Tandem sites responded, representing 331 systems.

NonStop 1	27
NonStop II	179

EXT	11
TXP	97
Not specified	17

38% were organizations under $50 million.
25% were organizations from $51 - 500 million.
37% were organizations over $500 million.

13% of Tandem users were OEM/System House.

>13 Stratus sites responded, representing 27 systems

XA200	3
XA400	9
XA600	2
Not specified	13

51% were organizations under $50 million.
38% were organizations from $51 - 500 million.
8% were organizations over $500 million.
(Note: survey does not total to 100%)

One-third of Stratus users were OEM/System House.

>For comparison, note that 2026 DEC sites responded, representing 8129 systems; 1866 IBM sites responded, representing 8472 systems.

\ov
Vendor Selection Criteria

>Tandem chosen for:	Percent of respondents citing:
System modularity/expandability	24.3%
System quality/reliability	20.7%
Networking/clustering	13.5%
Compatibility	8.2%
Vendor reputation	8.1%
CPU performance	7.2%

>DEC chosen for:	Percent of respondents citing:
Compatibility	14.5%
System quality/reliability	13.1%
Vendor reputation	11.6%
CPU performance	10.7%
Price	7.4%
Networking/clustering	7.3%

>No information on Stratus because of small sample.

\ov
Customer Satisfaction

>Percent of sites planning or considering a vendor change:

	1986	1985
Stratus	0.0%	n/a
Microdata	2.9	15.8
DEC	9.3	10.9
IBM	10.1	8.7
HP	12.4	8.0
Prime	13.8	12.7
AT&T	14.0	13.0
Tandem	15.4	3.3
All sites	14.6	14.9

[Note: represents 11 Tandem sites]

>Reason: Percent of sites planning or considering a vendor change dissatisfied with:

Networking	16.7%	(2 sites)
Price	33.3	(4 sites)
System reliability	0.0	
New product slate	50.0	(6 sites)
Software/support	0.0	
Sales/service orgn	66.7	(8 sites)
Financial stength	0.0	
Other	16.7	(2 sites)

[Note: For all companies, OEM's are particularly dissatisfied with sales/service organization.]

>Note the contrasting answer to the following question:
"What change in your attitude toward your current vendor has there been during the past year?"

Stratus	+42.0%	HP	+10.3%
Tandem	+25.0%	DG	+ 3.3%
Apollo	+20.0%	IBM	+ 2.8%
DEC	+18.3%	Sun	-13.3%
Prime	+12.9%	Wang	-14.4%

In other words, our customers in general have a more favorable view of Tandem, despite the negative rating by 11 sites.

\ov
Other Survey Results

>Tandem has the highest percentage usage for distributed business DP, software development, industrial automation and data communications. During the presentation of the survey results, Cowen commented that our showing in industrial automation shows the success of our industry strategy targeting manufacturing.

>"Highest incidence of advanced system software usage at Tandem and Stratus installed sites"

	DBMS	Remote Network	LAN	Transaction Processing
Tandem	86.2%	66.7%	41.7%	93.1%
Stratus	66.7	83.3	33.3	100.0
HP	83.3			
Harris		55.0		
Sun			80.0	
Microdata				77.8
DEC	55.0	33.1	35.3	37.8
IBM	44.7	38.0	17.5	60.5

[The response on LANs illustrates the fact that you have to take surveys with a grain of salt. We do not have a LAN, yet 41.7% of the respondants said they used our software for local area networks. Nonetheless, Tandem has consistently

dominated the category of advanced system software usage.]

>Spending plans Tandem versus Stratus

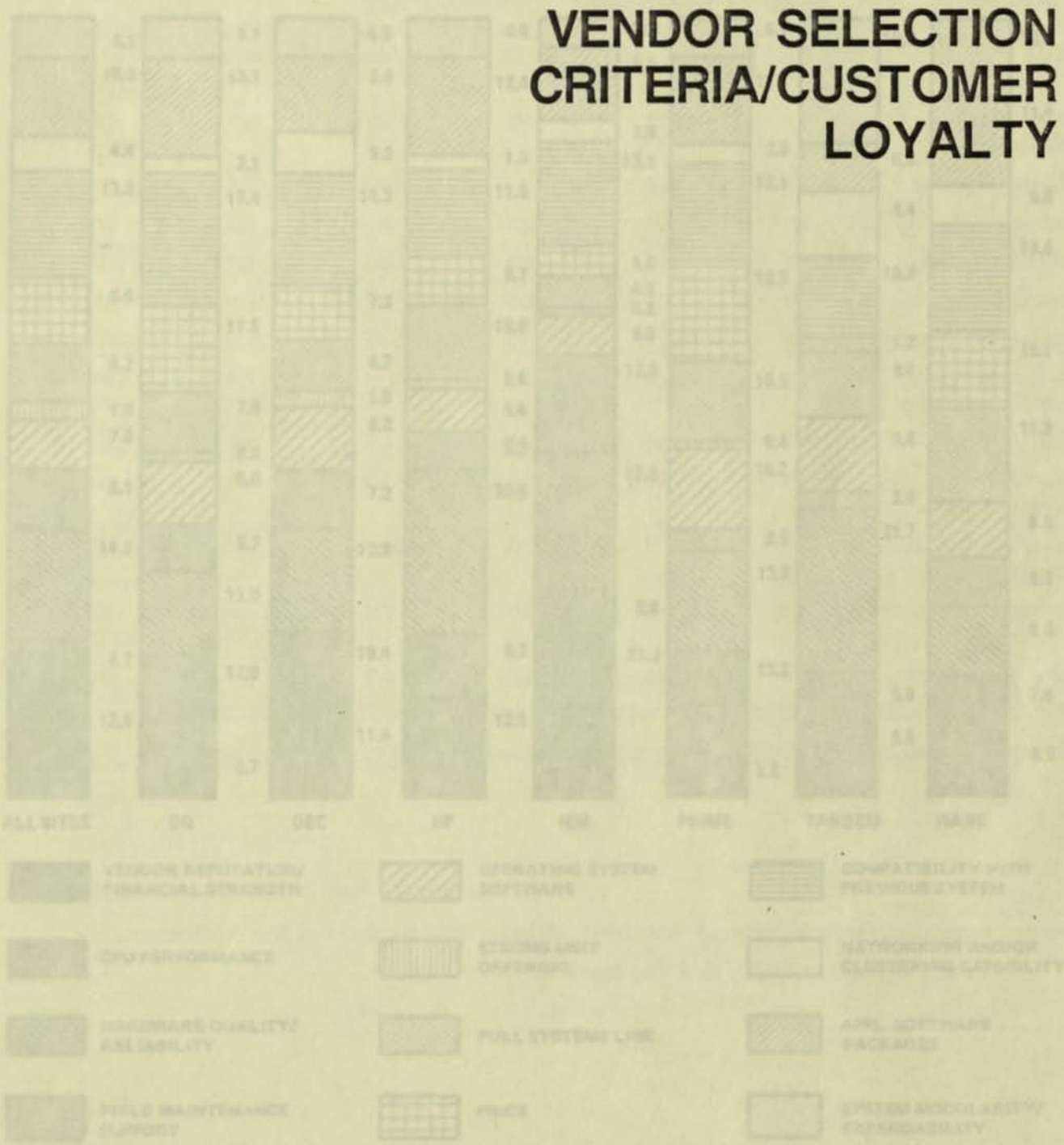
	1986	1985
Tandem	87.6%	86.4%
Stratus	12.4%	13.6%

These results reverse the trend from last year.
There were no IBM System/88 planned purchases in the survey.

Section

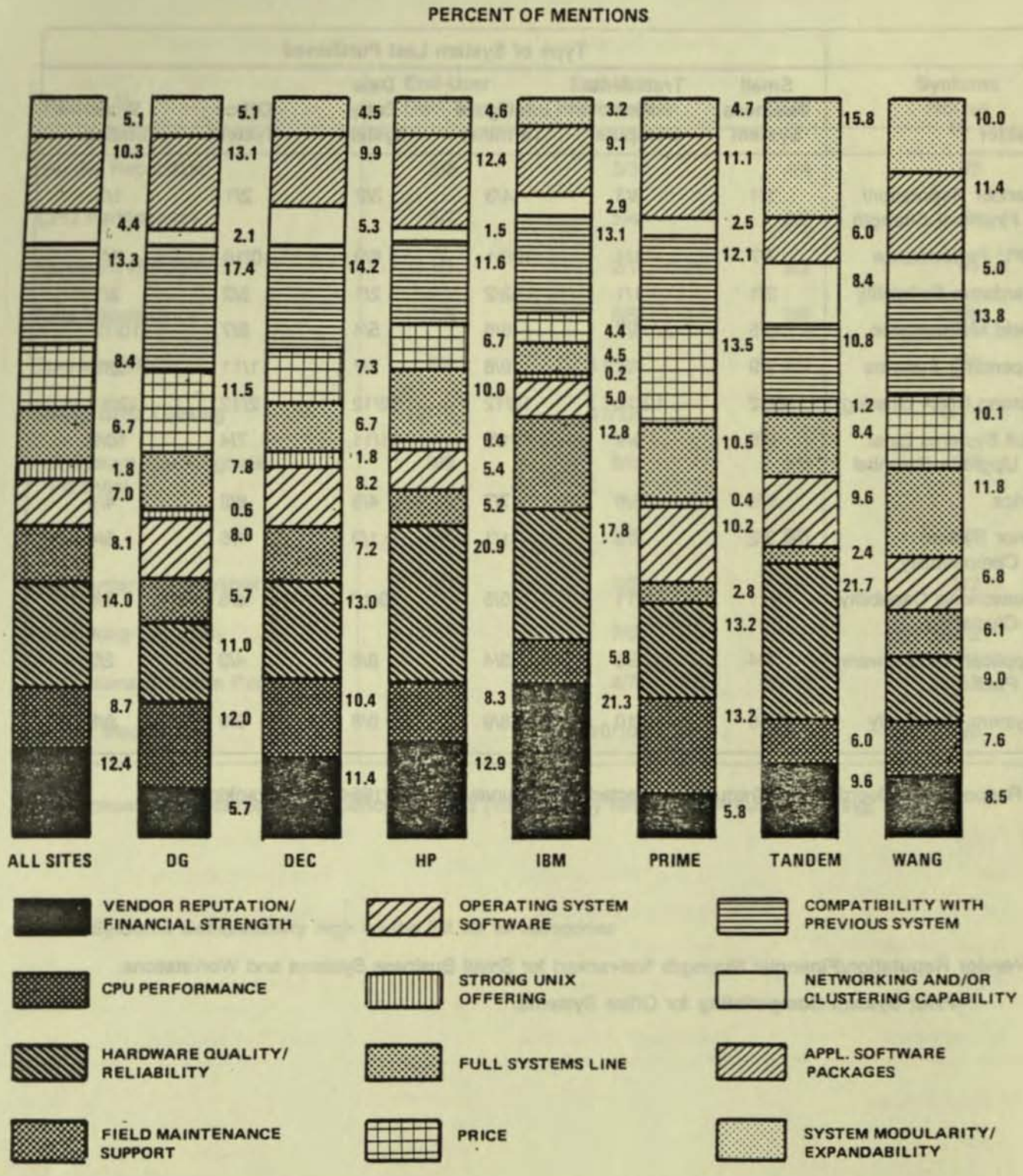
C

VENDOR SELECTION CRITERIA/CUSTOMER LOYALTY



DISTRIBUTION OF CRITERIA DEEMED MOST IMPORTANT BY RESPONDENTS IN CHOICE OF MINICOMPUTER SUPPLIER

Query: Which factors were most important in the selection of your minicomputer vendor?



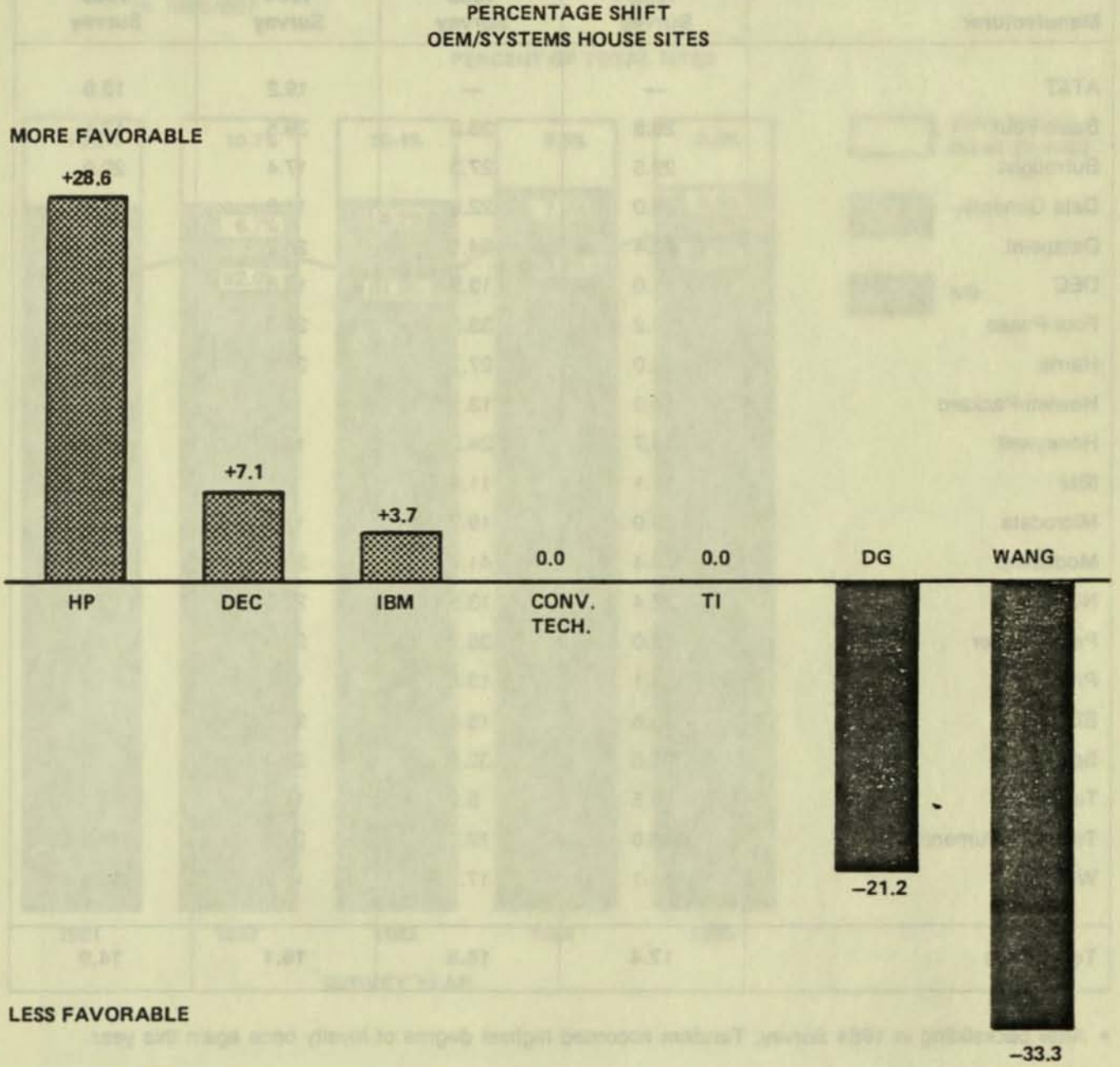
FIRST-RANKED FACTOR FOR SELECTION OF VENDOR, 1985 VERSUS 1984

Principal Supplier	Most Cited Selection Factor	
	1985 Survey	1984 Survey
Altos	Vendor Reputation* + Strong UNIX Offering*	Hardware Reliability* + Price*
Apollo	Networking Capability	Applications Software Packages
AT&T	Strong UNIX Offering	Strong UNIX Offering
Basic Four	Hardware Reliability* + System Compatibility*	Field Maintenance Support
Burroughs	System Compatibility* + Price*	System Compatibility
Convergent Technologies	System Modularity/Expandability	Applications Software Packages
Data General	System Compatibility	System Compatibility
Datapoint	Networking Capability	Networking Capability
DEC	System Compatibility	Hardware Reliability
Four-Phase	System Compatibility	Price
Harris	Price* + System Compatibility*	Price
Hewlett-Packard	Hardware Reliability	Hardware Reliability
Honeywell	Applications Software Packages	System Compatibility
IBM	Vendor Reputation	Vendor Reputation
Microdata	OP System Software	OP System Software
ModComp	System Compatibility	System Compatibility
Mohawk Data/Quantel	Applications Software Packages	Applications Software Packages
NCR	System Compatibility	Applications Software Packages
Perkin-Elmer	Price	Hardware Reliability* + System Compatibility*
Prime	Price	Price
SEL	CPU Performance	CPU Performance*, Hardware Reliability* + System Compatibility*
Sperry	Price	System Compatibility
Sun	Strong UNIX Offering	NA
Tandem	Hardware Reliability	Hardware Reliability
Texas Instruments	Hardware Reliability	Price
Wang	System Compatibility	Full Systems Line
All Suppliers	**Hardware Reliability**	**Hardware Reliability**

*Ranked equally

NET PAST-YEAR SHIFT IN RESPONDENT ATTITUDE TOWARD CURRENT SUPPLIER

Query: What, if any, change in your attitude toward your current minicomputer supplier has there been during the past year?



- For all OEM/Systems House survey sites +8.8%

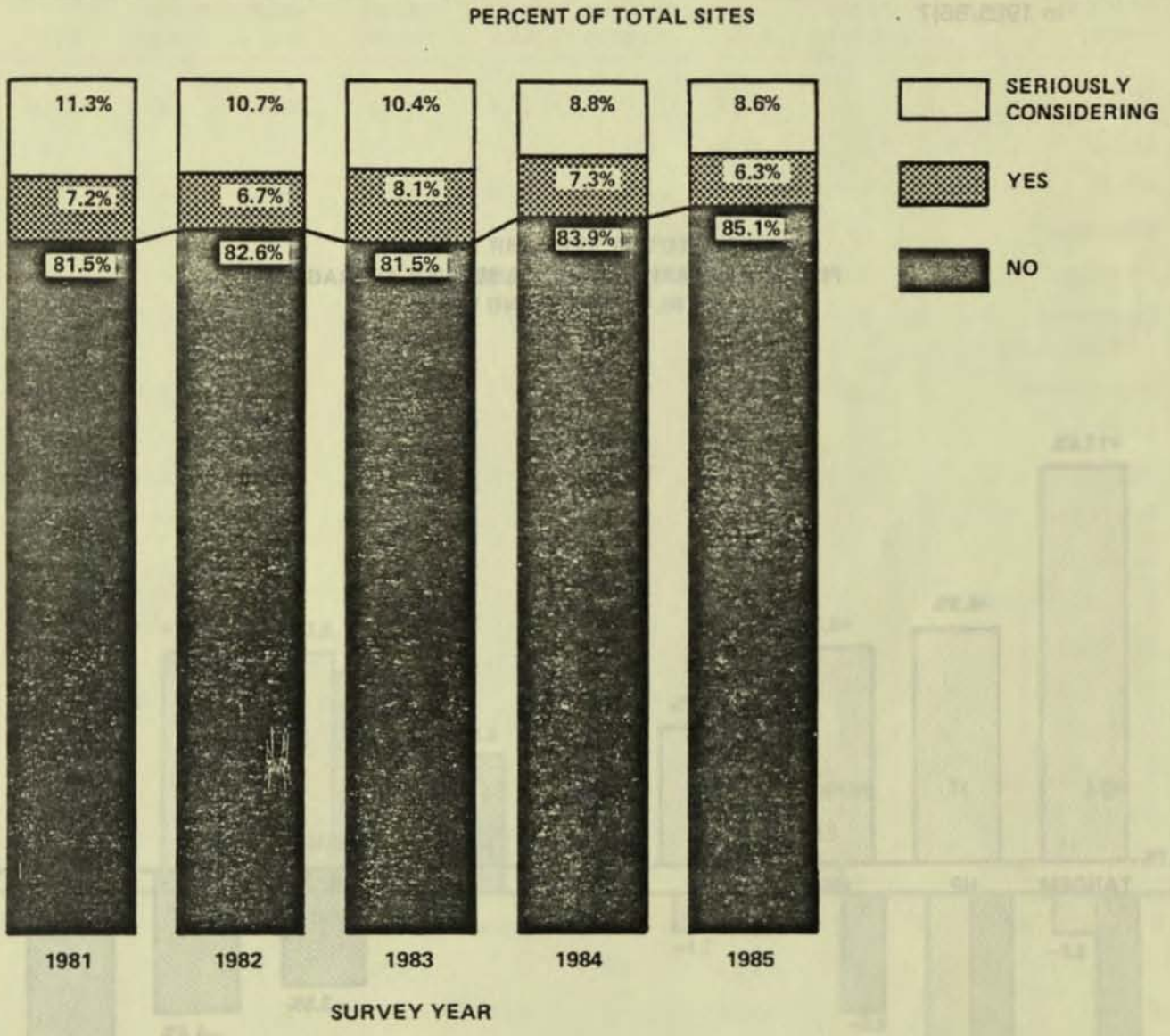
PERCENT OF SITES PLANNING/CONSIDERING VENDOR SWITCH, DISTRIBUTED BY CURRENT PRINCIPAL SUPPLIER

Manufacturer	1982 Survey	1983 Survey	1984 Survey	1985 Survey
AT&T	—	—	19.2	13.0
Basic Four	26.5	33.3	39.5	17.1
Burroughs	29.5	27.3	17.4	20.0
Data General	25.0	22.6	17.3	14.4
Datapoint	22.4	34.1	28.2	37.1
DEC	11.0	13.9	13.8	10.9
Four-Phase	29.2	33.3	25.0	31.6
Harris	25.0	27.7	24.1	13.0
Hewlett-Packard	14.3	13.1	9.1	8.0
Honeywell	15.7	24.2	17.0	15.9
IBM	11.1	11.4	9.1	8.7
Microdata	25.0	19.7	11.8	15.8
ModComp	36.4	41.4	23.8	45.5
NCR	22.4	13.9	22.0	19.4
Perkin-Elmer	18.0	35.7	22.9	15.4
Prime	14.1	13.5	13.4	12.7
SEL	13.6	15.4	22.2	13.3
Sperry	32.6	32.0	24.0	25.0
Tandem	7.5	5.9	14.3	3.3
Texas Instruments	16.8	19.8	27.1	19.3
Wang	16.1	17.9	15.2	18.4
Total Sites	**17.4**	**18.5**	**16.1**	**14.9**

- After backsliding in 1984 Survey, **Tandem** accorded highest degree of loyalty once again this year.
    - **HP** and **IBM** remain consistently near the top of these rankings.
- Among Workstation suppliers: **Sun** 9.1%, **Apollo** 16.7% (vs. 33.3% in 1984), **Altos** 25.0% (vs. 40.0%), **Convergent** 31.6% (vs. 8.3%).

GRADUALLY RISING TREND IN CUSTOMER LOYALTY TO CURRENT MINICOMPUTER SYSTEMS SUPPLIER PARALLELING ASCENDENCY OF COMPATIBILITY AS FACTOR IN CHOICE OF VENDOR

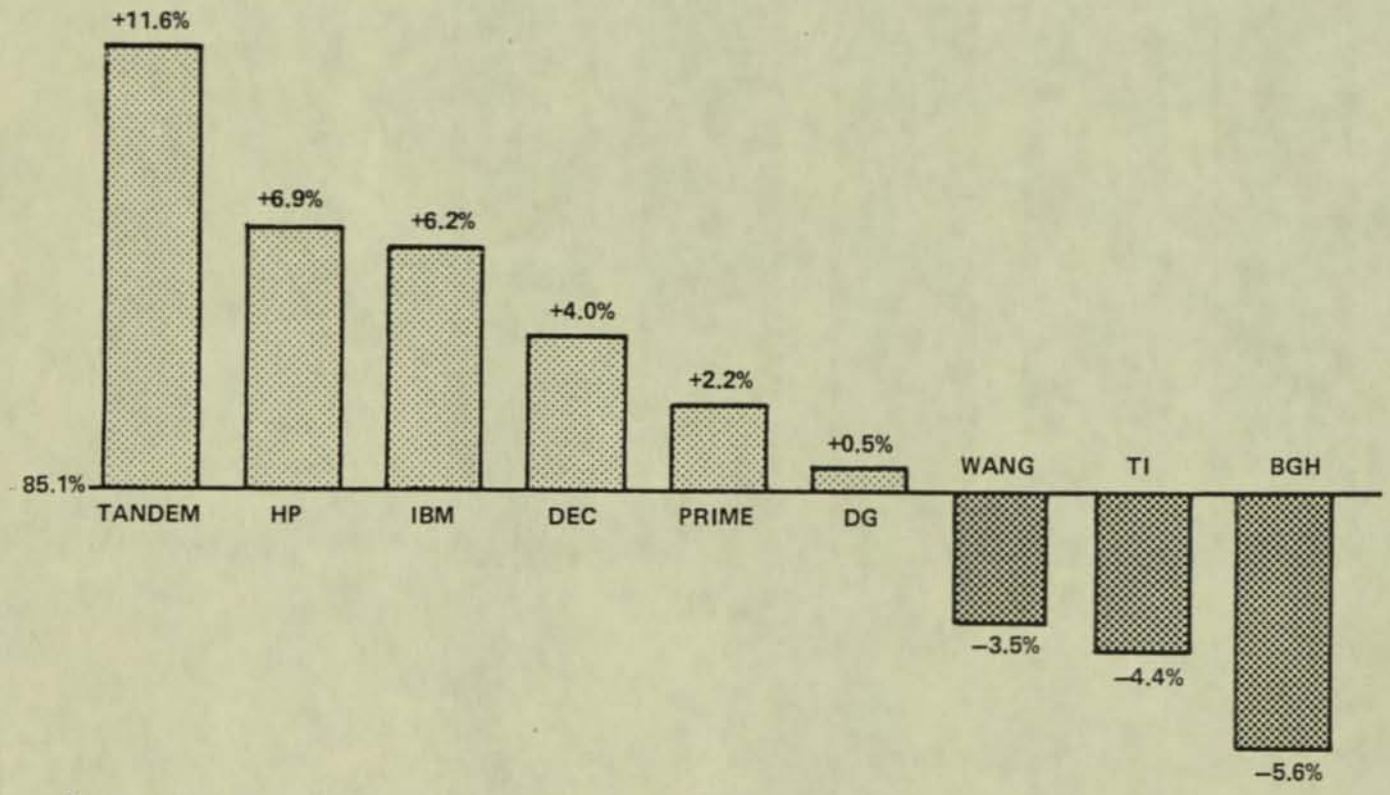
Query: Do you expect to change to another manufacturer as your principal source of minicomputers in 1985/86?



TANDEM, HP AND IBM AT HIGH END OF CUSTOMER LOYALTY SPECTRUM IN 1985 SURVEY

Query: Do you expect to change to another manufacturer as your primary source of minicomputers in 1985/86)?

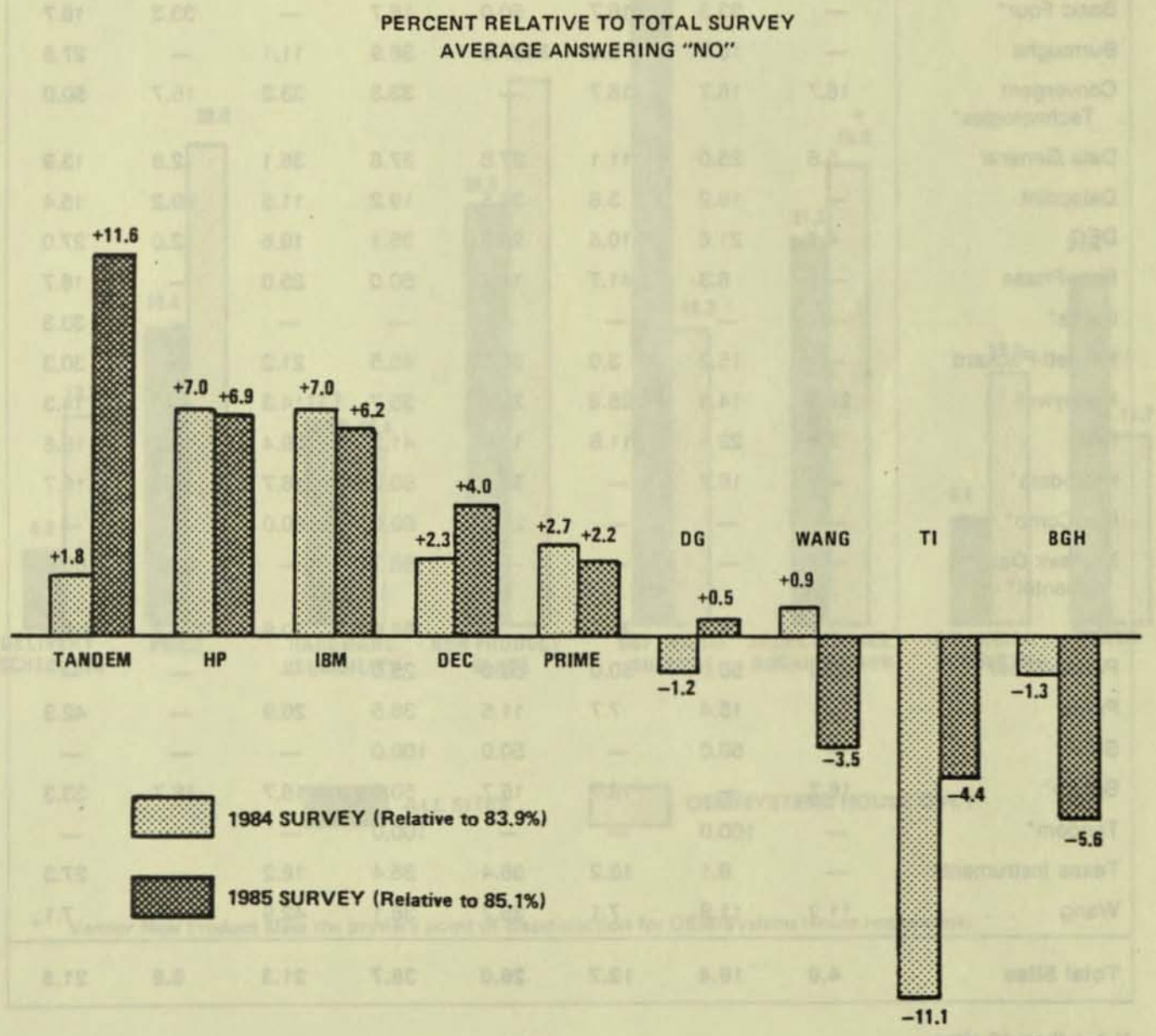
PERCENT RELATIVE TO TOTAL SURVEY AVERAGE
OF 85.1% ANSWERING "NO"*



* As opposed to answering "Yes" or "Seriously Considering"

SHIFT FROM LONG-STANDING NEGATIVE TREND IN CUSTOMER LOYALTY TO POSITIVE FOR FIRST TIME FOR DATA GENERAL

Query: Do you expect to change to another manufacturer as your primary source of minicomputers?



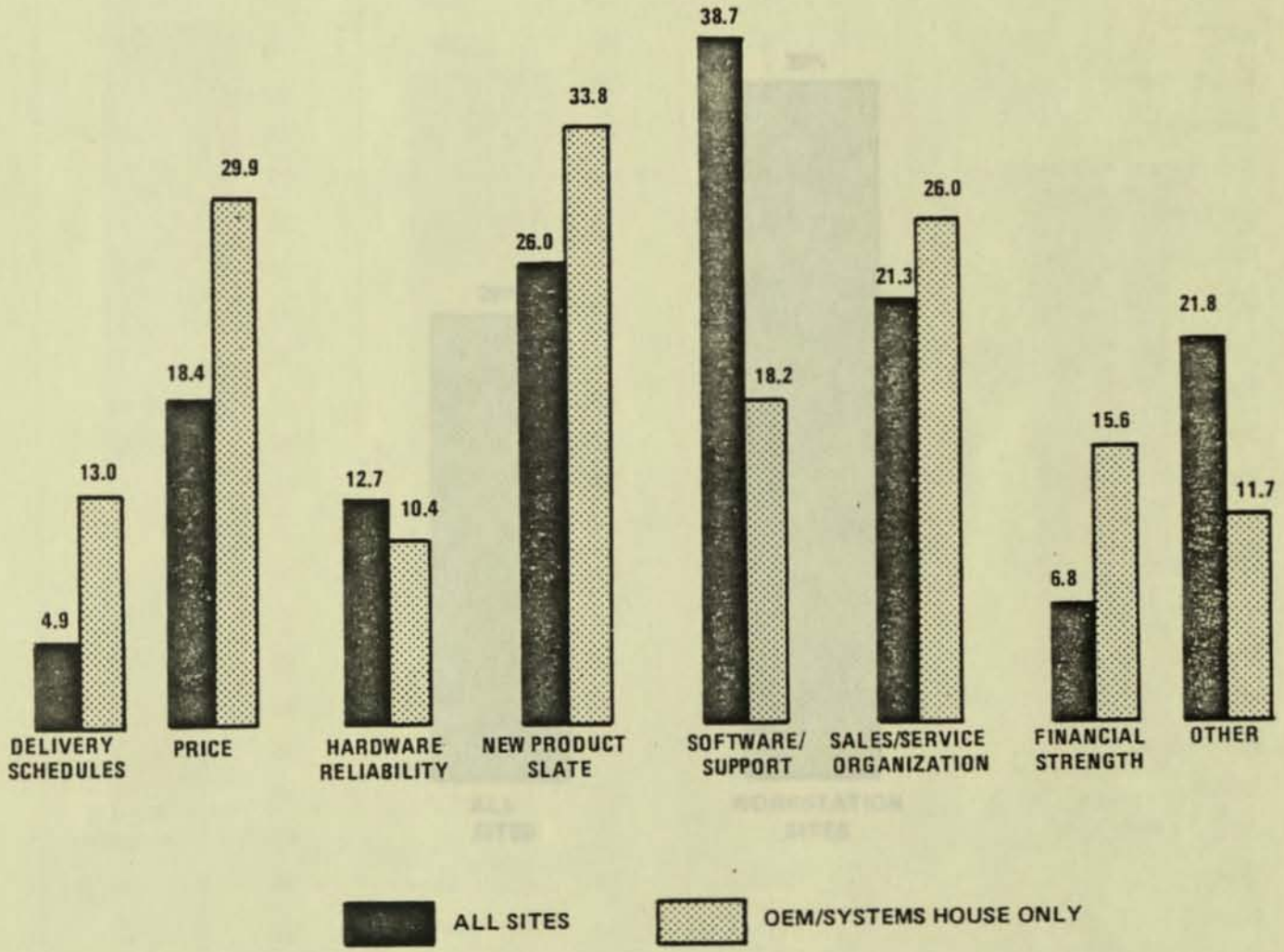
REASONS FOR PLANNING/CONSIDERING VENDOR SWITCH

—DISTRIBUTED BY CURRENT PRINCIPAL VENDOR—

Current Principal Vendor	Percent of "Switching Sites" Dissatisfied With:							
	Delivery Schedules	Price	Hardware Reliability	New Product Slate	Software Support	Sales/ Service Org.	Financial Strength	Other
Altos*	—	20.0	—	20.0	40.0	20.0	—	20.0
Apollo*	—	50.0	50.0	—	—	—	—	—
AT&T*	—	50.0	—	50.0	50.0	—	—	—
Basic Four*	—	33.3	16.7	50.0	16.7	—	33.3	16.7
Burroughs	—	16.7	5.6	27.8	38.9	11.1	—	27.8
Convergent Technologies*	16.7	16.7	16.7	—	33.3	33.3	16.7	50.0
Data General	5.6	25.0	11.1	27.8	27.8	36.1	2.8	13.9
Datapoint	—	19.2	3.8	38.5	19.2	11.5	69.2	15.4
DEC	4.7	21.6	10.8	24.3	35.1	19.6	2.0	27.0
Four-Phase	—	8.3	41.7	16.7	50.0	25.0	—	16.7
Harris*	—	—	—	—	—	—	—	33.3
Hewlett-Packard	—	15.2	3.0	30.3	45.5	21.2	—	30.3
Honeywell	28.6	14.3	28.6	28.6	35.7	14.3	—	14.3
IBM	2.9	22.5	11.8	19.6	41.2	29.4	2.9	18.6
Microdata*	—	16.7	—	33.3	50.0	16.7	—	16.7
ModComp*	—	—	—	20.0	60.0	60.0	—	—
Mohawk Data/ Quantel*	—	—	—	—	66.7	—	33.3	100.0
NCR	7.7	15.4	23.1	7.7	53.8	30.8	7.7	7.7
Perkin-Elmer*	25.0	50.0	50.0	50.0	25.0	—	—	—
Prime	—	15.4	7.7	11.5	38.5	26.9	—	42.3
SEL*	—	50.0	—	50.0	100.0	—	—	—
Sperry*	16.7	—	16.7	16.7	50.0	16.7	16.7	33.3
Tandem*	—	100.0	—	—	100.0	—	—	—
Texas Instruments	—	9.1	18.2	36.4	36.4	18.2	—	27.3
Wang	11.9	11.9	7.1	35.7	38.1	42.9	7.1	7.1
Total Sites	**4.9**	**18.4**	**12.7**	**26.0**	**38.7**	**21.3**	**6.8**	**21.8**

*Less than 10 sites

SOFTWARE/SUPPORT REMAINS MOST OFTEN CITED REASON FOR PLANNING/CONSIDERING A VENDOR SWITCH



- Vendor **New Product Slate** the primary point of dissatisfaction for OEM/Systems House respondents

DEGREE OF COMPETITION BY PRINCIPAL SUPPLIER

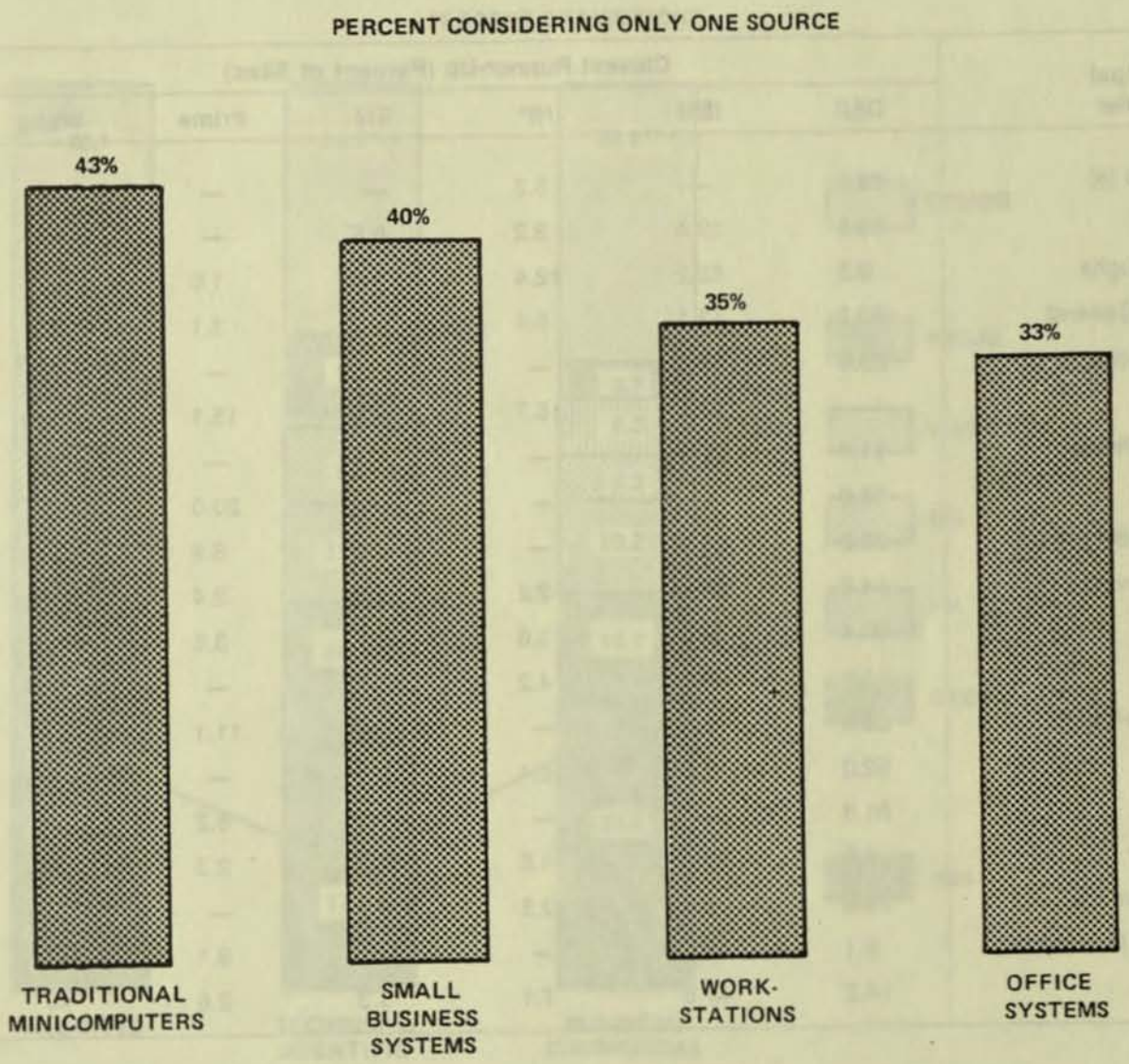
Query: How many separate vendors (i.e., manufacturers) did you consider before making your most recent minicomputer purchase decision?

Principal Supplier	Percent of Respondent Sites Considering Only One Vendor				
	1981 Survey	1982 Survey	1983 Survey	1984 Survey	1985 Survey
Altos	NA	NA	NA	6	20
Apollo	NA	NA	NA	17	50
AT&T	NA	NA	NA	42	28
Basic Four	33	24	13	22	14
Burroughs	33	25	28	26	30
Convergent Technologies	NA	NA	NA	17	26
Data General	33	40	36	33	36
Datapoint	36	45	39	41	62
DEC	34	43	45	44	47
Four-Phase	15	41	35	35	34
Harris	8	23	8	17	38
Hewlett-Packard	26	27	32	39	40
Honeywell	26	38	38	37	34
IBM	36	42	43	43	48
Microdata	19	21	19	20	13
ModComp	39	50	38	57	64
Mohawk Data/Quantel	NA	NA	NA	33	6
NCR	23	28	35	20	31
Perkin-Elmer	38	46	36	33	39
Prime	20	21	26	40	32
SEL	42	36	26	17	53
Sperry	19/38*	24	30	28	33
Sun	NA	NA	NA	NA	25
Tandem	30	26	26	40	40
Texas Instruments	24	33	36	45	48
Wang	24	26	26	34	36
All Sites	**29**	**36**	**31**	**30**	**32**

*Univac/Varian

SURVEY EVIDENCES HIGHEST DEGREE OF COMPETITIVE ACTIVITY IN OFFICE SYSTEMS SEGMENT OF MARKET

Query: How many separate vendors (i.e., manufacturers) did you consider before making your most recent minicomputer purchase decision?



IBM MORE OFTEN THAN DEC THE CLOSEST COMPETITOR IN MULTIPLE SUPPLIER PROCUREMENTS ON COMMERCIAL SIDE OF MINICOMPUTER MARKET

Query: If more than one vendor was considered in your most recent minicomputer acquisition, which was the closest runner-up to the vendor actually chosen?

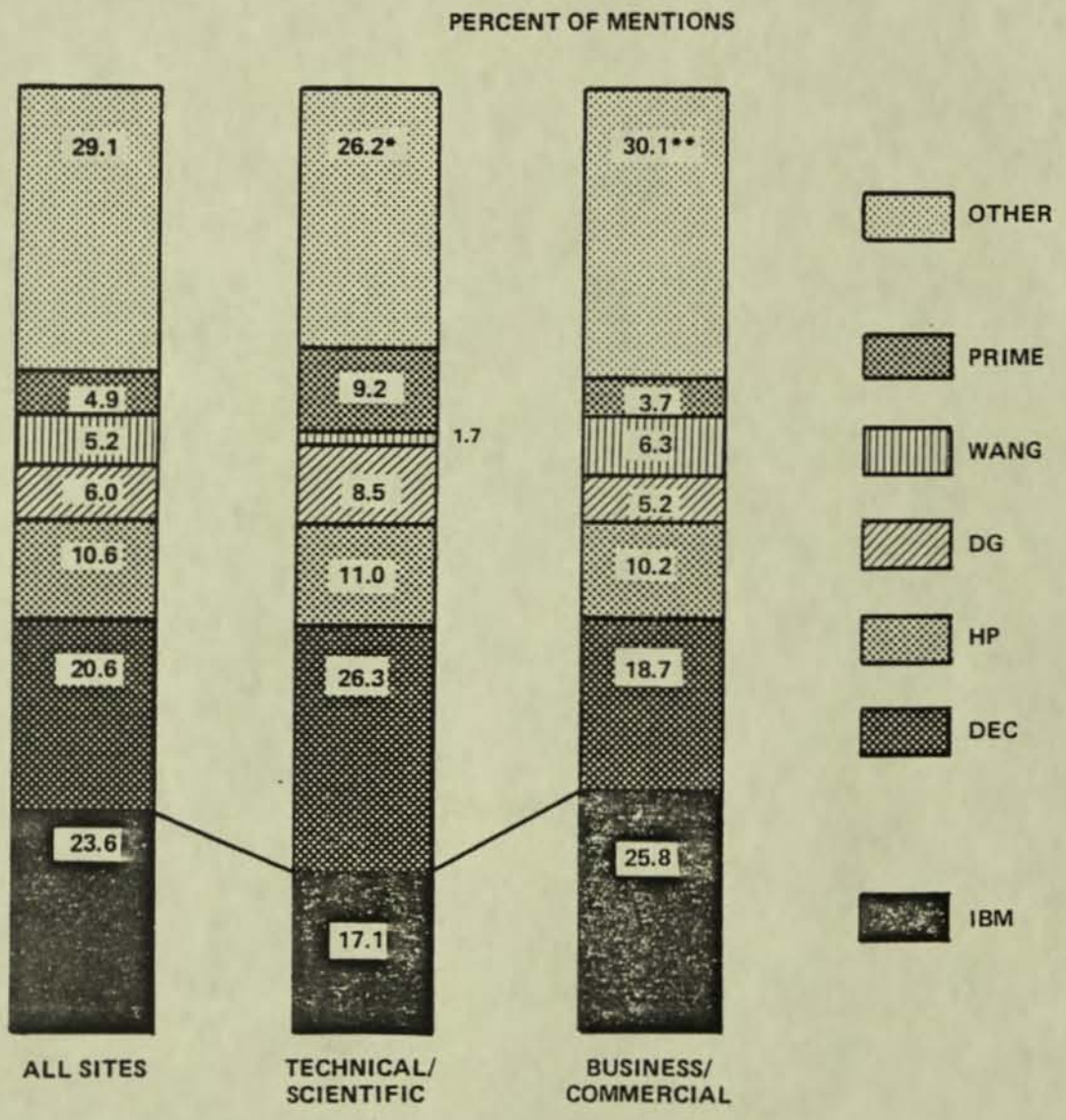
Principal Supplier	Closest Runner-Up (Percent of Sites)					
	DEC	IBM	HP	DG	Prime	Wang
Apollo (a)	66.7	—	8.3	—	—	—
AT&T	35.5	19.4	3.2	6.5	—	—
Burroughs	9.5	52.2	12.4	4.8	1.0	2.8
Data General	50.7	13.1	5.4	—	3.1	8.5
Datapoint	20.0	35.0	—	—	—	10.0
DEC	—	24.2	16.7	10.9	15.1	5.1
Four-Phase	11.1	22.2	—	11.1	—	11.1
Harris	30.0	—	—	—	20.0	—
Hewlett-Packard	33.2	30.6	—	3.4	6.9	5.3
Honeywell	14.6	24.4	12.2	4.9	2.4	4.9
IBM	30.4	—	13.6	6.2	3.6	9.7
NCR	11.1	40.2	4.2	—	—	5.5
Perkin-Elmer	55.4	5.6	—	—	11.1	—
Prime	52.0	7.5	10.4	9.4	—	3.8
SEL	81.3	—	—	—	6.2	—
Sperry	4.5	59.2	4.5	—	2.3	2.3
Tandem (b)	49.8	6.3	12.5	6.3	—	—
Texas Instruments	9.1	45.4	—	9.1	9.1	9.1
Wang	14.2	47.6	7.1	5.3	2.6	—

(a) Sun Microsystems—8.3% (50.0% in 1984 survey)

(b) Stratus—6.3% (23.5%)

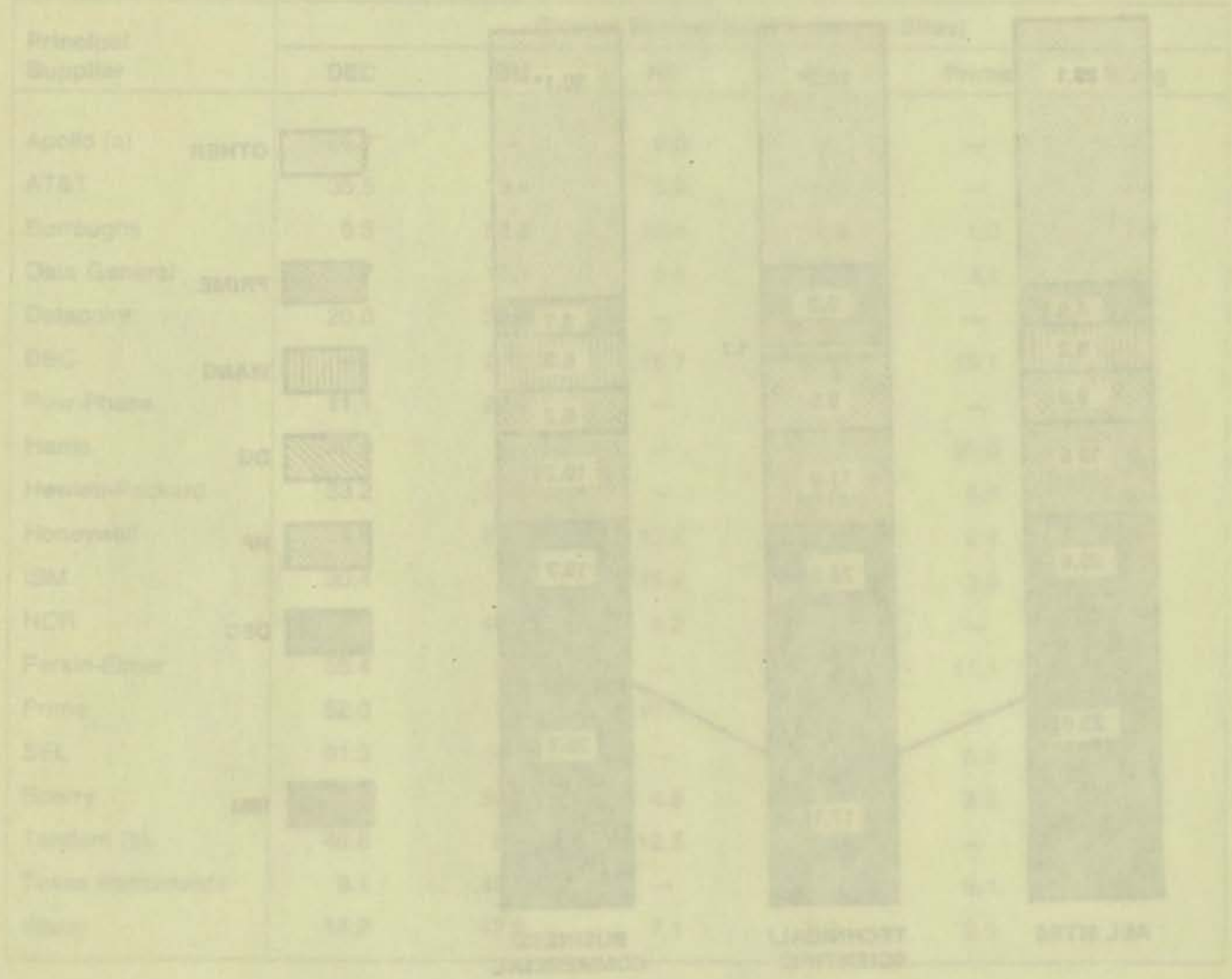
DEC THE MOST FREQUENTLY CITED AS CLOSEST COMPETITOR IN TECHNICAL/SCIENTIFIC SYSTEMS ARENA, IBM IN BUSINESS/COMMERCIAL AND OVERALL

Query: If more than one vendor was considered in your most recent minicomputer acquisition, which was the closest runner-up to the vendor actually chosen?



*Includes SEL 2.5%, Apollo 2.1%, P-E 1.7%, Sun 1.5%

**Includes Burroughs 6.6%, NCR 4.3%



User Ratings of Mainframes

This report presents the results of Datapro's 1984 survey of computer users. User experiences with over 1000 mainframe systems have been summarized and are presented in the accompanying tables. These user ratings evaluate the performance, reliability, and vendor support for the most popular mainframes sold today. The information provided by the actual users of these systems can aid a prospective user in the evaluation of a computer acquisition.

Datapro is pleased to present, in conjunction with *Computerworld*, the 1984 edition of the annual Computer Users Survey. This year's survey is based on responses to questionnaires mailed to a cross-section of computer sites listed with International Data Corporation (IDC). This report summarizes the results received from mainframe users. For the results of the minicomputer users polled, please refer to *Datapro Reports on Minicomputers*. The users were asked to rate their systems in 25 subjective categories and respond to a variety of questions covering such areas as system configuration, languages, and data base management. They were also asked if they would recommend the system to other users.

Our purpose in using IDC's list of known computer sites was twofold: to select only currently marketed system models, and to improve the results for those models. The number of responses received for models which are no longer in production, like the IBM System/370 or IBM System/3, was dramatically reduced. In addition, the number of responses received for the systems we selected increased in over 50 percent of the cases. By using IDC's list, we also received responses for systems recently introduced. Nine users of the IBM 4361/4381, delivered for the first time early in 1984, responded to our questionnaire, and the Sperry 1100/70 was also included in the survey for the first time.

We would like to stress that individual profiles or ratings should never be the major consideration in making an acquisition decision. The reader can use the material in this report to help formulate questions about a computer system as the evaluation process proceeds. The information within this report is very informative if used with discretion and with the understanding that there are many factors involved in selecting the right computer system to meet your particular needs.

SURVEY METHODOLOGY

The 1984 survey has been based on results received from 15,000 questionnaires mailed to known computer users listed with IDC. The total number of questionnaires was divided into two groups: 9000 surveys were mailed to minicomputer users and 6000 to mainframe users. In addition, the users were chosen based on the computer system they had installed. Datapro supplied IDC with a list of specific system models to be included in the mailing and the model was listed directly on the mailing label. In an effort to improve the response rate and thereby increase the statistical validity, the users were contacted twice; a first request was followed two weeks later by a second request.

Each questionnaire allowed the user to rate one computer system and specifically requested that the rating apply to the system listed on the label. The recipient was encouraged to reproduce the form if he/she wished to rate additional systems. The IDC labels were used as initial validation vehicles and for identification and elimination of invalid and duplicate returns. All returns were analyzed by senior Datapro analysts and some returns were judged invalid for one or more of the following reasons: more than one system model was rated on a single form; the response was a duplicate; the form was received after the deadline; the ratings section of the questionnaire was not completed; the systems rated were not mainframe or minicomputer systems; or the response revealed a vested interest on the part of the respondent. In addition, system models receiving less than five responses were not included in the final analysis, although the responses were considered to be valid.

Of the 15,000 questionnaires mailed, 3404 responses were received from 3261 respondents, a return of 22 percent on the total mailing. Of the total responses, 352 were judged to be invalid, giving us 3052 valid responses from 2909 users. Of these valid responses, 1079 rated mainframe computer systems, for a return of 18 percent on the 6000 surveys mailed to mainframe users, and 1973 rated minicomputer systems, for a return of 22 percent on the 9000 surveys mailed to minicomputer users.

Datapro batched the valid returns by manufacturer and model and sent the returns to Mathematica Policy Research, Inc. for tabulation of the results. The summary information was prepared in the form of either averages, percentages or weighted averages. Weighted averages were computed in a manner similar to most college grading systems: "Excellent" is weighted as 4, "Good" as 3, "Fair" as 2, and "Poor" as 1. The tallied numbers for each value are then multiplied by the corresponding weight, and the average is taken by dividing the sum of the products by the total number of responses for that category.

THE 1984 QUESTIONNAIRE

Users were asked to answer 27 multiple-part questions. Each user was asked to identify the manufacturer and model of his/her system, as well as the month and year of acquisition and the method of acquisition. Users were requested to identify the type of industry their company was in, principal applications, and the source of those applications programs. We also asked the users for information about their hardware and software configurations, and about acquisitions or implementations planned for 1984.

User Ratings of Mainframes

Chart 2. Computer Usage by Manufacturer and Industry Type

Manufacturer \ Type of Industry	Banking/Finance/ Securities	Chemical/ Petroleum	Construction	Education	Engineering/ Scientific	Government	Health Care/ Medical	Insurance	Legal	Manufacturing	Media	Public Accounting/ Consulting	Retail/Wholesale	Service Bureau	Transportation	Utilities (Public)	Other
Amdahl (30)	3.33	0.00	0.00	3.33	0.00	23.33	0.00	16.67	0.00	16.67	0.00	0.00	3.33	16.67	0.00	13.33	3.33
Burroughs (113)	23.89	1.77	0.00	6.19	0.88	15.93	7.96	2.65	0.00	17.70	1.77	0.88	8.85	2.65	3.54	0.00	5.31
Digital Equipment (53)	0.00	0.00	1.89	41.51	3.77	1.89	3.77	1.89	0.00	13.21	3.77	0.00	3.77	13.21	0.00	1.89	9.43
Honeywell (45)	2.22	2.22	4.44	11.11	2.22	15.56	4.44	11.11	0.00	20.00	2.22	0.00	11.11	0.00	4.44	2.22	6.67
IBM (561)	8.20	2.85	0.36	8.02	1.60	5.88	3.39	6.77	0.18	31.02	1.07	0.18	9.63	4.99	1.60	5.53	8.73
IPL (12)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.33	0.00	8.33	0.00	0.00	0.00	41.67	8.33	0.00	33.33
Magnuson (7)	0.00	0.00	0.00	0.00	0.00	14.29	0.00	14.29	0.00	0.00	14.29	0.00	0.00	28.57	0.00	0.00	28.57
NAS (13)	0.00	7.69	0.00	7.69	0.00	15.38	7.69	0.00	0.00	7.69	0.00	0.00	23.08	23.08	0.00	0.00	7.69
NCR (141)	26.24	0.00	0.71	6.38	0.00	6.38	6.38	0.71	0.71	14.18	0.00	0.71	19.86	10.64	2.13	2.13	2.84
Sperry (79)	1.27	2.53	0.00	11.39	7.59	10.13	2.53	1.27	0.00	25.32	1.27	0.00	8.86	7.59	5.06	6.33	8.86
Other (22)	9.09	0.00	0.00	18.18	4.55	31.82	4.55	0.00	0.00	4.55	0.00	0.00	4.55	0.00	9.09	0.00	13.64
All Mainframes (1076)	10.69	2.04	0.56	9.57	1.86	8.64	4.18	5.20	0.19	23.98	1.21	0.28	10.32	6.88	2.32	4.18	7.90

The remaining questions asked the users to rate various aspects of their computer systems. The categories rated included: ease of operation, reliability of system, reliability of peripherals, maintenance service (responsiveness and effectiveness), technical support (troubleshooting, education, and documentation), manufacturer's software (operating system, compilers and assemblers, and application programs), ease of programming, ease of conversion, and overall satisfaction. Additional ratings added this year included: ease of reconfiguration, compatibility of terminals, peripherals, and software carried over from other systems, power/energy efficiency, productivity aids, software/support promised by the vendor, delivery of hardware and required software, noise level of equipment, and ease of keeping up with and implementing vendor changes to hardware/software. In addition, if utilizing a data base management system or communications monitor, users were asked to identify the vendor and package and to rate the technical support and their overall satisfaction with the package.

Finally, we asked if the computer system did what it was expected to do, and if the users would recommend their computer system to others.

SURVEY RESULTS

Table 1, "Mainframes," contains the results on 21 model groupings from 10 mainframe and plug-compatible mainframe vendors, representing 1079 user responses. Table 2, "Mainframe Vendor Summaries," contains summaries by vendor of the information in Table 1.

Financial Alternatives

Users have three options by which they can acquire their computer system: purchase, rent/lease from the manufacturer, or lease from a third party. Each method of acquisition offers its own benefits and each method should be examined carefully to see which of these methods would be most beneficial to your company. By using the purchase option, the user can enjoy benefits such as the investment tax credit and depreciation schedule allowances. With the rapid advances in technology, however, many users feel that rental/lease from the manufacturer is the best option for them—because it allows them to upgrade faster to new systems. Also, many vendors include maintenance in the rent/lease price. The advantages a user can receive from third-party leasing are faster delivery and more attractive lease prices.

One of the questions we asked, therefore, was how users acquired their systems: outright purchase, rental/lease from the manufacturer, or third-party lease.

Reference to Chart 1 shows that the percentage of purchased systems has increased again this year. This is undoubtedly because many vendors, including IBM, are making outright purchase more attractive by lowering purchase prices and raising rental and lease prices.

Method of Acquisition	1984	1983	1982
Purchase (%)	51	44	38
Rent/Lease from Mfgr. (%)	24	34	41
Lease from 3rd Party (%)	25	22	21

Chart 1. Financial alternatives.

Industry and Applications

One of the questions we asked the users was "What type of industry describes your company?" Chart 2 shows the

User Ratings of Mainframes

Chart 4. Usage of Local and Remote Workstations/Terminals

No. of Workstations/ Terminals per System / Manufacturer & Model	Local						Remote					
	None	1-5	6-15	16-30	31-60	Over 60	None	1-5	6-15	16-30	31-60	Over 60
Amdahl												
470/580	1	1	1	4	7	15	2	1	2	0	1	23
Burroughs												
B 2800, B 3800, B 4800	0	2	4	4	2	4	3	4	2	1	1	5
B 2900, B 3900, B 4900	1	8	13	19	14	17	13	10	11	10	9	18
B 5900	0	2	3	2	7	1	3	2	3	2	2	2
B 6900	0	0	1	3	4	2	2	1	1	1	2	2
Digital Equipment												
DECsystem -10/-20	1	1	13	13	8	17	3	8	8	8	9	15
Honeywell												
DPS 7	0	2	1	4	4	0	4	1	1	3	2	0
DPS 8	1	0	4	11	4	14	4	2	7	6	2	13
IBM												
4331	3	15	68	58	33	6	66	51	30	14	15	6
4341	2	0	16	68	81	76	42	32	41	28	40	57
4361 & 4381	0	0	1	3	3	2	2	1	2	1	1	2
303X Series	0	0	0	3	4	17	0	1	1	6	2	14
308X Series	1	0	5	5	9	69	3	1	5	4	11	64
Other Models	0	1	5	2	2	2	1	6	1	2	0	2
IPL Systems												
4400 Series	0	1	4	1	3	3	5	2	0	0	0	5
Magnuson												
M80 Series	0	1	2	1	2	1	2	3	1	1	0	0
NAS												
AS/6000, AS/7000, AS/9000	0	0	0	2	4	7	1	2	1	2	2	5
NCR												
8400/8500/8600	3	20	41	47	25	5	36	23	21	20	16	22
Sperry												
1100/60	1	0	9	14	15	9	7	11	9	8	5	8
1100/70	0	0	2	3	3	3	0	2	2	3	0	3
1100/80	0	0	0	3	2	15	1	1	2	1	1	13
Other Mainframes	0	2	8	4	2	6	5	1	1	4	2	9
All Mainframes	14	56	201	274	238	291	205	166	152	125	123	288

market penetration in each industry by manufacturer for each class of computer systems.

We also asked the survey respondents to specify their principal applications. In 1984, as in 1983, the top three applications were: accounting/billing, payroll/personnel, and order processing/inventory control. (See Chart 3, "User Rankings of Principal Applications.") Purchasing, in fifth place last year, moved up to fourth place this year. Education, not in the top ten last year, moved up to seventh place.

Applications—1984	Applications—1983
1. Accounting/Billing	1. Accounting/Billing
2. Payroll/Personnel	2. Payroll/Personnel
3. Order Processing/Inv. Control	3. Order Processing/Inv. Control
4. Purchasing	4. Sales/Distribution
5. Sales/Distribution	5. Purchasing
6. Manufacturing	6. Manufacturing
7. Education	7. Banking
8. Banking	8. Math./Statistics
9. Engineering/Scientific	9. Engineering/Scientific
10. Math./Statistics	10. Insurance

Chart 3. User rankings of principal applications

Hardware Configurations

Several of the survey questions asked users to describe their hardware configurations. Fifty-four percent of the mainframes represented in the survey had from two to eight megabytes of main memory, and sixty-six percent had over 1.2 gigabytes of disk storage. Less than two percent of the systems had more than 32 megabytes of main memory.

In the continuing trend to bring computers to the people who need them, workstations/terminals are the primary means of implementation. We asked the users how many local workstations/terminals and how many remote workstations/terminals they were using. Chart 4 shows the usage of local and remote terminals by manufacturer and model. About 27 percent of the mainframe users had over 60 local terminals and over 60 remote terminals in operation.

This year, we also asked the users if they had installed microcomputers in addition to their mainframes. A list of popular microcomputer vendors was provided. The most frequently checked vendor was IBM, with 618 responses, followed by Apple, with 335 responses, and Radio Shack,

User Ratings of Mainframes

Chart 4. Usage of Local and Remote Workstations/Terminals

Manufacturer & Model / No. of Workstations/ Terminals per System	Local						Remote					
	None	1-5	6-15	16-30	31-60	Over 60	None	1-5	6-15	16-30	31-60	Over 60
Amdahl												
470/580	1	1	1	4	7	15	2	1	2	0	1	23
Burroughs												
B 2800, B 3800, B 4800	0	2	4	4	2	4	3	4	2	1	1	5
B 2900, B 3900, B 4900	1	8	13	19	14	17	13	10	11	10	9	18
B 5900	0	2	3	2	7	1	3	2	3	2	2	2
B 6900	0	0	1	3	4	2	2	1	1	1	2	2
Digital Equipment												
DECsystem -10/-20	1	1	13	13	8	17	3	8	8	8	9	15
Honeywell												
DPS 7	0	2	1	4	4	0	4	1	1	3	2	0
DPS 8	1	0	4	11	4	14	4	2	7	6	2	13
IBM												
4331	3	15	68	58	33	6	66	51	30	14	15	6
4341	2	0	16	68	81	76	42	32	41	28	40	57
4361 & 4381	0	0	1	3	3	2	2	1	2	1	1	2
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Other Models	0	1	5	2	2	2	1	6	1	2	0	2
IPL Systems												
4400 Series	0	1	4	1	3	3	5	2	0	0	0	5
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M80 Series	0	1	2	1	2	1	2	3	1	1	0	0
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AS/6000, AS/7000, AS/9000	0	0	0	2	4	7	1	2	1	2	2	5
NCR												
8400/8500/8600	3	20	41	47	25	5	36	23	21	20	16	22
Sperry												
1100/60	1	0	9	14	15	9	7	11	9	8	5	8
1100/70	0	0	2	3	3	3	0	2	2	3	0	3
1100/80	0	0	0	3	2	15	1	1	2	1	1	13
Other Mainframes	0	2	8	4	2	6	5	1	1	4	2	9
All Mainframes	14	56	201	274	238	291	205	166	152	125	123	288

market penetration in each industry by manufacturer for each class of computer systems.

We also asked the survey respondents to specify their principal applications. In 1984, as in 1983, the top three applications were: accounting/billing, payroll/personnel, and order processing/inventory control. (See Chart 3, "User Rankings of Principal Applications.") Purchasing, in fifth place last year, moved up to fourth place this year. Education, not in the top ten last year, moved up to seventh place.

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3. Order Processing/Inv. Control	3. Order Processing/Inv. Control
4. Purchasing	4. Sales/Distribution
5. Sales/Distribution	5. Purchasing
6. Manufacturing	6. Manufacturing
7. Education	7. Banking
8. Banking	8. Math./Statistics
9. Engineering/Scientific	9. Engineering/Scientific
10. Math./Statistics	10. Insurance

Chart 3. User rankings of principal applications.

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This year, we also asked the users if they had installed microcomputers in addition to their mainframes. A list of popular microcomputer vendors was provided. The most frequently checked vendor was IBM, with 618 responses, followed by Apple, with 335 responses, and Radio Shack,

User Ratings of Mainframes

with 193 responses. These responses represented over 7100 IBM micros, over 4700 Apples, and over 1700 Radio Shack units.

Software

The computer application development life cycle is a highly labor-intensive cycle. As labor costs climb, so does the cost of software development. As computers increase in capability and speed, and as users become accustomed to results, the clamor for additional applications increases. Because many systems already face a two-year backlog in bringing up desirable applications, it is quite common for users to seek multiple sources for applications programs. And as the proprietary software industry increases in maturity and sophistication, "packaged software" becomes a desirable adjunct to in-house development.

We asked the users how they acquired their applications software. First on the list was in-house personnel. The preparation of software by in-house personnel is often a highly desirable route because of in-house management control plus the total tailorability of the software to the user's operational requirements (ideally). Packages from independent suppliers came in second place, followed by packages from the manufacturer, contract programming, and programs prepared by the manufacturer's personnel. The 1984 results on this question were identical to the 1983 results.

"Which programming language should I use?" is a question that often results in a long debate among programmers and computer scientists. Since most studies show that it takes about the same amount of time to code an instruction, whatever the language, the answer would appear to be: "Whichever language will result in the fastest possible documented implementation of the application."

For mainframe users, the most frequently used language was Cobol, followed distantly by Fortran, Assembler, and RPG.

We also asked the respondents if they were using a data base management system or a data communications monitor. Fifty-three percent were using a DBMS, while sixty-one percent were using a communications monitor. Additionally, users were asked to identify and rate the packages they used. The results are summarized in Charts 8 and 9 in the "User Satisfaction Ratings" section.

Acquisition Plans

We asked how users were planning to spend their enhancement/acquisition dollars in 1984. Chart 5 shows the user rankings of planned acquisitions. This year the top priority with users in the mainframe class is to expand their data communications facilities, followed closely by expansions to their present hardware. Additional proprietary software slipped from first place in 1983 to third place in 1984. Distributed processing moved up into fifth place this year.

Acquisition Plans—1984	Acquisition Plans—1983
1. Expansions to Data Communications (65%)	1. Additional Proprietary Software (54%)
2. Expansions to Present Hardware (64%)	2. Expansions to Data Communications (52%)
3. Additional Proprietary Software (59%)	3. Expansions to Present Hardware (51%)
4. Additional Software from Mfgr. (49%)	4. Additional Software from Mfgr. (44%)
5. Distributed Processing (25%)	5. Implement Disaster Recovery Plan (22%)

Chart 5. User rankings of planned acquisitions.

Office automation has been one of the "hot topics" during the past few months, so we asked the users if they had implemented office automation. Only 13 percent said they had done so, but 22 percent reported plans for office automation.

User Satisfaction Ratings

Consistent with our belief that what users think is extremely important, we asked users to rate their computer systems and the associated software and vendor support by assigning a rating of Excellent, Good, Fair, or Poor to each of 14 factors: ease of operation, reliability of mainframe, reliability of peripherals, maintenance service (responsiveness and effectiveness), technical support (troubleshooting, education, and documentation), manufacturer's software (operating system, compilers and assemblers, and applications programs), ease of programming, ease of conversion, and overall satisfaction. All ratings are expressed in terms of Weighted Averages, which were calculated by assigning a weight of 4 to each user rating of Excellent, 3 to Good, 2 to Fair, and 1 to Poor, and then dividing the sum by the number of users who rated each factor.

The individual responses by vendor model appear in Table 1. In analyzing the ratings, we decided to see how many systems could meet the following criteria for special merit: a minimum of 20 user responses, an overall satisfaction rating of at least 3.20, and a rating of no less than 2.80 in all other system rating categories. Only two systems met these criteria:

	Overall Satisfaction	Lowest Score	No. of Responses
IBM 303X Series	3.29	2.83	24
IBM 308X Series	3.24	2.84	89

For a number of other categories, we picked out those systems that received at least 20 responses and a rating of at least 3.50. Chart 6 shows the systems that met these criteria for ease of operation, reliability of mainframe, reliability of peripherals, operating system, and compilers and assemblers. In the ease of programming and ease of conversion categories, none of the systems met the criteria.

User Ratings of Mainframes

	Weighted Average	No. of Responses
Ease of Operation		
Burroughs B 2900/ B 3900/B 4900	3.76	72
Digital Equipment DECsystem-10/-20	3.62	54
Reliability of Mainframe		
IBM 303X Series	3.83	24
IBM 4341	3.75	244
IBM 4331	3.69	184
IBM 308X Series	3.69	89
Sperry 1100/80	3.60	20
Amdahl 470/580	3.57	30
Sperry 1100/60	3.56	48
Reliability of Peripherals		
IBM 4331	3.51	184
IBM 4341	3.51	244
Operating System		
Burroughs B 2900/ B 3900/B 4900	3.79	72
Digital Equipment DECsystem-10/-20	3.52	54
Sperry 1100/80	3.50	20
Compilers & Assemblers		
Sperry 1100/80	3.58	20
IBM 303X Series	3.50	24

Chart 6. Systems with the highest ratings in key categories.

Vendor service and support are key areas when considering a computer system. Although users have no control over the effectiveness of maintenance service, they can influence promptness of maintenance service by spelling out their requirements in their contract with the vendor. Chart 7 lists those vendors that received the highest overall ratings for maintenance service and technical support. To be listed in this chart, the vendor had to have a minimum of 20 user responses and a rating of at least 3.5 for maintenance service and 3.0 for technical support. Through the years that Datapro has been conducting this survey, we have found that the area of technical support usually receives the lowest ratings. We felt, therefore, that any vendor receiving a 3.0 rating in technical support was deserving of special mention. Amdahl was the only vendor that met our criteria for both maintenance service and technical support, although IBM and Digital Equipment made the list for trouble shooting.

	Weighted Average	No. of Responses
Maintenance Service		
Responsiveness: Amdahl	3.83	30
Effectiveness: Amdahl	3.60	30
Technical Support		
Troubleshooting: Amdahl	3.47	30
IBM	3.08	562
Digital Equipment	3.00	54
Education: Amdahl	3.27	30
Documentation: Amdahl	3.03	30

Chart 7. Vendors receiving highest ratings for service and support.

This year, we asked those respondents who said they were using a data base management system or communications monitor to specify the name of the vendor and package and then to rate the package. Chart 8 lists all DBMS packages that received at least 10 user responses. The list is in alphabetical order by vendor. Weighted averages are given for both technical support and overall satisfaction.

DBMS Systems	Weighted Averages	
	Technical Support	Overall Satisfaction
Applied Data Research Datacom/DB (11)	3.36	3.55
Burroughs DMS–II (128)*	3.01	3.49
Cincom Total (62)*	3.03	3.06
Cullinet IDMS (46)	3.17	3.41
Digital Equipment DBMS (17)*	2.65	2.82
Honeywell DM–IV (18)	3.11	3.22
Honeywell IDS (15)	3.07	3.20
IBM IMS (41)	3.02	2.95
IBM IMS/DB (16)	2.69	2.50
IBM DL/1 (102)	2.81	2.83
Software AG ADABAS (24)	2.83	3.13
Software House 1022 (14)	3.43	3.50
Sperry DMS/1100 (42)	3.02	3.38

**Count includes both mainframe and minicomputer users.*

Chart 8. User ratings of data base management systems.

We also asked the users who had communications monitors to rate them. Chart 9 lists, in alphabetical order by vendor, all communications monitors that received at least 10 responses.

Communications Monitors	Weighted Averages	
	Technical Support	Overall Satisfaction
Burroughs MCS (25)*	3.00	3.32
Burroughs NDL (12)*	2.92	3.42
Century Analysis Inc. Boss/3 (26)	3.08	3.46
IBM CICS (326)	3.03	3.10
IBM IMS/DC (14)	2.93	2.93
Sperry CMS (26)	3.04	3.23
Westinghouse Westi (12)	3.17	3.42

**Count includes both mainframe and minicomputer users.*

Chart 9. User ratings of communications monitors.

Expectations and Recommendations

We asked the computer system users "Did the system do what you expected it to do?" Ninety-six percent answered "Yes," two percent said "No," and two percent said "Haven't decided." In 1983, only 91 percent said their systems performed as expected.

User Ratings of Mainframes

The final question we asked users was whether they would recommend the computer system to another user in their situation. Ninety-two percent said "Yes," four percent answered "No," and four percent said they "Haven't decided." These responses show an improvement over 1983, when only 83 percent said they would recommend their systems, 8 percent said they would not, and 9 percent were undecided.

The vendors that received the highest overall percentages of user recommendations were:

Amdahl	97%
IBM	96%
Burroughs	94%
IPL	92%

THANK YOU

Datapro extends a sincere thanks to all for responding so enthusiastically to our 1984 survey of user experiences with computer systems. Without your participation it could not have been the success it is, and we hope that this compendium of the opinions of user colleagues will be of significant value to you. We look forward to hearing from you again next year. □

User Ratings of Mainframes

TABLES 1 AND 2

User Ratings of Mainframes

Table 1. MAINFRAMES

Survey Item \ Manufacturer and Model	Amdahl 470/580	Burroughs B 2800, B 3800, B 4800	Burroughs B 2900, B 3900, B 4900	Burroughs B 5900	Burroughs B 6900	Digital Equipment DECsystem-10/-20	Honeywell DPS 7	Honeywell DPS 8
No. of User Responses	30	16	72	16	10	54	11	34
Avg. Life of System (months)	38.6	59.1	30.0	26.2	37.6	70.1	25.3	33.0
Acquisition Method (%)								
Purchase	43.33	37.50	54.17	68.75	70.00	84.62	72.73	52.94
Rental or Lease from Mfr.	26.67	43.75	33.33	18.75	30.00	1.92	18.18	26.47
Lease from 3rd Party	30.00	18.75	12.50	12.50	0.00	13.46	9.09	20.59
Principal Applications (%)								
Accounting/Billing	76.67	56.25	69.44	68.75	80.00	64.81	90.91	82.35
Banking—Check Processing/Loans/Savings	6.67	37.50	33.33	6.25	0.00	0.00	9.09	5.88
Construction/Architecture	6.67	0.00	0.00	6.25	0.00	5.56	9.09	5.88
Education—Scheduling/Administration	6.67	0.00	4.17	6.25	50.00	42.59	0.00	20.59
Engineering/Scientific	23.33	6.25	5.56	6.25	30.00	27.78	0.00	5.88
Health Care/Medical	20.00	6.25	16.67	12.50	0.00	7.41	9.09	5.88
Insurance	26.67	0.00	11.11	12.50	0.00	9.26	9.09	17.65
Manufacturing	23.33	25.00	12.50	18.75	30.00	9.26	18.18	20.59
Mathematics/Statistics	30.00	0.00	2.78	12.50	50.00	35.19	0.00	23.53
Order Processing/Inventory Control	36.67	31.25	41.67	56.25	40.00	29.63	81.82	41.18
Payroll/Personnel	76.67	62.50	65.28	50.00	80.00	55.56	72.73	61.76
Petroleum/Fuel Analysis	3.33	0.00	5.56	0.00	0.00	1.85	9.09	2.94
Process Control	3.33	0.00	1.39	12.50	10.00	0.00	0.00	5.88
Purchasing	20.00	37.50	26.39	31.25	50.00	31.48	27.27	32.35
Sales/Distribution	30.00	31.25	20.83	31.25	30.00	12.96	63.64	26.47
Other	13.33	12.50	19.44	6.25	10.00	14.81	9.09	11.76
Source of Applications Programs (%)								
In-house Personnel	93.33	87.50	83.33	87.50	100.00	98.15	100.00	100.00
"Packaged" Programs from Manufacturer	33.33	43.75	34.72	25.00	10.00	25.93	18.18	35.29
Contract Programming	43.33	18.75	16.67	25.00	20.00	11.11	27.27	23.53
Manufacturer's Personnel	3.33	0.00	0.00	6.25	10.00	1.85	9.09	11.76
Independent Suppliers	40.00	56.25	51.39	31.25	50.00	51.85	36.36	35.29
Using Data Base Management System (%)	79.31	18.75	54.17	75.00	80.00	57.41	36.36	82.35
Planning a Data Base Management System in 1984	0.00	18.75	16.67	6.25	20.00	11.11	18.18	8.82
Manufacturer's Package	0.00	66.67	79.49	100.00	100.00	16.13	100.00	100.00
Outside Vendor's Package	95.65	0.00	0.00	0.00	0.00	45.16	0.00	0.00
Using Communications Monitor (%)	80.00	37.50	33.82	31.25	40.00	16.33	36.36	46.67
Planning a Communications Monitor in 1984	0.00	12.50	7.35	0.00	10.00	2.04	9.09	10.00
Manufacturer's Package	0.00	16.67	60.87	100.00	75.00	12.50	0.00	0.00
Outside Vendor's Package	83.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Using Integrated Office Automation Functions (%)	23.33	13.33	8.57	0.00	0.00	27.45	9.09	12.12
Planning Office Automation Functions in 1984	26.67	13.33	20.00	35.71	20.00	23.53	0.00	15.15
Have a Disaster Recovery Plan (%)	66.67	62.50	54.93	33.33	20.00	47.17	45.45	29.41
Plan to in 1984	16.67	12.50	25.35	13.33	60.00	15.09	27.27	41.18

User Ratings of Mainframes

Table 1. MAINFRAMES

Amdahl 470/580	Burroughs B 2800, B 3800, B 4800	Burroughs B 2900, B 3900, B 4900	Burroughs B 5900	Burroughs B 6900	Digital Equipment DECsystem-10/-20	Honeywell DPS 7	Honeywell DPS 8	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
50.00	25.00	38.89	43.75	50.00	22.22	36.36	61.76	Additional Software from the Manufacturer
83.33	31.25	41.67	43.75	60.00	40.74	36.36	50.00	Proprietary Software from Other Suppliers
76.67	37.50	70.83	56.25	90.00	51.85	90.91	67.65	Expansions to Data Communications Facilities
26.67	12.50	30.56	18.75	40.00	22.22	27.27	23.53	Distributed Processing Capabilities
76.67	37.50	63.89	37.50	70.00	59.26	45.45	55.88	Expansions to Present Hardware
13.33	6.25	11.11	18.75	40.00	16.67	9.09	8.82	Business Graphics
6.67	6.25	11.11	0.00	10.00	12.96	18.18	8.82	Power Conditioning Systems
								System Ratings (4.0-1.0)
3.43	3.75	3.76	3.56	3.70	3.62	3.27	3.27	Ease of Operation
3.57	3.44	3.49	3.31	3.10	3.35	3.64	3.39	Reliability of Mainframe
3.38	3.06	3.03	3.31	3.00	3.15	3.55	3.24	Reliability of Peripherals
								Maintenance Service:
3.83	3.06	3.33	3.19	3.40	3.40	3.18	3.45	Responsiveness
3.60	3.00	3.22	2.88	3.30	3.25	3.09	3.06	Effectiveness
								Technical Support:
3.47	3.00	2.77	2.94	3.00	3.00	2.73	2.91	Trouble-shooting
3.27	2.56	2.69	2.67	2.78	2.67	2.64	2.73	Education
3.03	2.44	2.61	2.19	2.67	2.81	2.64	2.47	Documentation
								Manufacturer's Software:
3.12	3.69	3.79	3.56	3.90	3.52	3.18	3.21	Operating System
3.11	3.31	3.32	3.25	3.70	3.36	3.27	3.21	Compilers & Assemblers
2.85	2.93	2.69	2.82	2.67	2.85	2.40	2.52	Applications Programs
2.78	3.47	3.46	3.31	3.40	3.39	3.00	3.09	Ease of Programming
2.90	3.21	3.36	3.14	3.20	3.06	3.09	2.81	Ease of Conversion
3.14	3.40	3.31	3.31	3.30	3.31	3.09	3.03	Overall Satisfaction
								Additional Ratings (4.0-1.0)
3.45	3.47	3.49	3.40	3.30	3.20	3.36	3.13	Ease of Reconfiguration
3.69	2.69	3.14	3.13	3.00	3.27	2.91	2.41	Compatibility of Hardware carried over from other systems
3.72	2.88	3.18	3.07	3.10	2.98	3.27	2.61	Compatibility of Programs/data carried over from other systems
3.19	2.69	3.37	3.13	2.80	2.52	3.00	3.00	Power/energy Efficiency
2.95	2.93	2.96	2.63	3.30	2.63	2.64	2.48	Productivity Aids help keep programming costs low
3.30	2.69	2.75	2.63	2.90	2.58	2.89	2.68	Software/Support promised by vendor
3.13	3.25	3.39	3.06	3.10	2.85	3.30	2.97	Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
3.03	2.50	2.89	2.81	2.80	2.90	3.00	2.97	Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
3.08	2.63	2.93	2.94	3.00	2.75	2.73	2.85	Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
100.00	93.33	100.00	75.00	90.00	90.74	100.00	97.06	Yes
0.00	6.67	0.00	12.50	10.00	3.70	0.00	2.94	No
0.00	0.00	0.00	12.50	0.00	5.56	0.00	0.00	Undecided
								Would you recommend system to another user? (%)
96.67	86.67	98.57	81.25	90.00	79.63	90.91	76.47	Yes
3.33	0.00	1.43	6.25	10.00	12.96	9.09	5.88	No
0.00	13.33	0.00	12.50	0.00	7.41	0.00	17.65	Undecided

User Ratings of Mainframes

Table 1. MAINFRAMES

Survey Item \ Manufacturer and Model	IBM 4331	IBM 4341	IBM 4361 & 4381	IBM 303X	IBM 308X	IBM Other Models	IPL 4400	Magnuson M80
No. of User Responses	184	244	9	24	89	12	12	7
Avg. Life of System (months)	43.7	35.1	17.0	36.6	20.8	89.5	28.3	30.4
Acquisition Method (%)								
Purchase	56.28	44.03	44.44	54.17	56.18	50.00	33.33	50.00
Rental or Lease from Mfr.	20.77	18.52	22.22	4.17	10.11	0.00	66.67	33.33
Lease from 3rd Party	22.95	37.45	33.33	41.67	33.71	50.00	0.00	16.67
Principal Applications (%)								
Accounting/Billing	80.98	82.79	77.78	79.17	76.40	75.00	25.00	42.86
Banking—Check Processing/Loans/Savings	10.33	9.84	0.00	12.50	8.99	8.33	0.00	14.29
Construction/Architecture	1.09	3.28	0.00	4.17	3.37	0.00	8.33	0.00
Education—Scheduling/Administration	14.13	14.34	11.11	8.33	14.61	8.33	0.00	0.00
Engineering/Scientific	4.89	15.16	33.33	8.33	31.46	0.00	0.00	0.00
Health Care/Medical	6.52	7.38	11.11	4.17	11.24	0.00	0.00	0.00
Insurance	9.78	7.79	0.00	12.50	14.61	8.33	25.00	14.29
Manufacturing	32.61	31.97	33.33	16.67	25.84	16.67	16.67	0.00
Mathematics/Statistics	8.15	11.89	11.11	4.17	21.35	16.67	0.00	14.29
Order Processing/Inventory Control	53.80	58.61	66.67	50.00	50.56	50.00	33.33	14.29
Payroll/Personnel	64.67	65.16	66.67	54.17	64.04	66.67	41.67	28.57
Petroleum/Fuel Analysis	1.09	2.05	0.00	0.00	4.49	0.00	0.00	0.00
Process Control	8.15	5.33	0.00	12.50	7.87	0.00	0.00	0.00
Purchasing	35.87	46.31	44.44	45.83	43.82	16.67	16.67	0.00
Sales/Distribution	42.39	37.30	22.22	20.83	31.46	25.00	16.67	14.29
Other	10.33	11.89	0.00	29.17	16.85	41.67	41.67	42.86
Source of Applications Programs (%)								
In-house Personnel	92.39	95.90	100.00	100.00	97.75	100.00	100.00	100.00
"Packaged" Programs from Manufacturer	32.07	42.62	44.44	58.33	57.30	50.00	0.00	28.57
Contract Programming	20.11	26.64	11.11	41.67	33.71	25.00	16.67	28.57
Manufacturer's Personnel	1.09	0.82	0.00	8.33	3.37	33.33	0.00	0.00
Independent Suppliers	33.15	52.05	33.33	62.50	56.18	16.67	8.33	57.14
Using Data Base Management System (%)	31.49	50.42	62.50	73.91	79.78	58.33	16.67	14.29
Planning a Data Base Management System in 1984	9.94	11.86	12.50	4.35	7.87	0.00	16.67	14.29
Manufacturer's Package	56.14	63.02	60.00	47.06	49.30	28.57	0.00	0.00
Outside Vendor's Package	28.07	29.41	20.00	41.18	33.80	57.14	100.00	100.00
Using Communications Monitor (%)	67.96	78.66	75.00	91.67	77.91	50.00	75.00	42.86
Planning a Communications Monitor in 1984	5.52	6.28	0.00	8.33	5.81	8.33	0.00	0.00
Manufacturer's Package	85.37	84.57	83.33	86.36	74.63	66.67	0.00	0.00
Outside Vendor's Package	7.32	9.57	16.67	9.09	4.48	16.67	66.67	66.67
Using Integrated Office Automation Functions (%)	4.00	10.57	22.22	4.55	29.07	0.00	8.33	0.00
Planning Office Automation Functions in 1984	13.14	23.35	33.33	63.64	25.58	16.67	0.00	16.67
Have a Disaster Recovery Plan (%)	42.86	52.50	22.22	62.50	61.80	50.00	18.18	71.43
Plan to in 1984	19.23	22.92	33.33	25.00	16.85	8.33	27.27	14.29

User Ratings of Mainframes

Table 1. MAINFRAMES

IBM 4331	IBM 4341	IBM 4361 & 4381	IBM 303X	IBM 308X	IBM Other Models	IPL 4400	Magnuson M80	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
36.96	56.56	77.78	87.50	77.53	66.67	16.67	0.00	Additional Software from the Manufacturer
48.91	67.62	66.67	95.83	87.64	41.67	75.00	57.14	Proprietary Software from Other Suppliers
50.00	65.57	44.44	91.67	85.39	58.33	75.00	57.14	Expansions to Data Communications Facilities
15.76	24.59	11.11	54.17	38.20	0.00	16.67	14.29	Distributed Processing Capabilities
55.43	67.21	66.67	87.50	76.40	50.00	58.33	71.43	Expansions to Present Hardware
4.89	13.52	11.11	29.17	29.21	0.00	8.33	14.29	Business Graphics
3.80	9.02	11.11	20.83	12.36	25.00	0.00	28.57	Power Conditioning Systems
								System Ratings (4.0-1.0)
3.14	3.19	3.33	3.18	3.26	3.00	3.58	3.43	Ease of Operation
3.69	3.75	3.89	3.83	3.69	3.17	3.75	3.57	Reliability of Mainframe
3.51	3.51	3.00	3.21	3.43	3.17	3.17	3.57	Reliability of Peripherals
								Maintenance Service:
3.45	3.48	3.56	3.67	3.47	3.08	3.08	3.71	Responsiveness
3.46	3.47	3.56	3.54	3.36	3.25	3.33	3.43	Effectiveness
								Technical Support:
3.01	3.03	3.22	3.42	3.26	2.83	3.25	2.86	Trouble-shooting
2.89	2.97	3.00	3.42	3.05	3.36	2.80	2.00	Education
2.85	2.83	3.00	3.13	2.98	3.00	3.00	2.29	Documentation
								Manufacturer's Software:
3.19	3.13	3.11	3.38	3.34	3.17	3.38	3.20	Operating System
3.37	3.22	3.22	3.50	3.33	3.25	3.56	3.20	Compilers & Assemblers
2.91	2.87	3.11	2.83	2.84	2.64	3.13	2.67	Applications Programs
2.99	2.91	2.78	2.83	2.93	3.09	3.00	3.00	Ease of Programming
2.87	2.82	2.88	2.91	3.04	2.90	2.86	3.00	Ease of Conversion
3.17	3.11	3.11	3.29	3.24	3.36	3.25	3.33	Overall Satisfaction
								Additional Ratings (4.0-1.0)
2.98	3.06	3.44	3.22	3.19	2.92	3.27	3.17	Ease of Reconfiguration
3.04	3.25	3.25	3.57	3.38	2.92	3.50	3.80	Compatibility of Hardware carried over from other systems
2.97	3.21	3.33	3.57	3.35	3.08	3.30	3.20	Compatibility of Programs/data carried over from other systems
3.25	3.27	3.44	2.70	3.28	1.92	3.60	3.17	Power/energy Efficiency
2.69	2.71	2.89	3.00	2.67	2.90	2.88	2.50	Productivity Aids help keep programming costs low
2.86	2.83	3.00	3.30	2.94	3.09	2.60	2.00	Software/Support promised by vendor
2.88	2.83	3.00	2.67	2.82	3.18	2.60	3.33	Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
2.99	2.99	3.33	3.04	3.13	3.08	3.00	2.86	Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
2.97	2.95	2.89	3.00	3.06	3.08	2.89	3.00	Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
98.37	98.36	100.00	100.00	98.88	100.00	100.00	100.00	Yes
0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.00	No
1.63	0.82	0.00	0.00	1.12	0.00	0.00	0.00	Undecided
								Would you recommend system to another user? (%)
95.08	97.54	100.00	91.67	98.88	58.33	91.67	57.14	Yes
0.55	0.41	0.00	0.00	0.00	41.67	8.33	14.29	No
4.37	2.05	0.00	8.33	1.12	0.00	0.00	28.57	Undecided

User Ratings of Mainframes

Table 1. MAINFRAMES

Survey Item \ Manufacturer and Model	NAS AS/6000, AS/7000, AS/9000	NCR 8400/8500/8600	Sperry 1100/80	Sperry 1100/70	Sperry 1100/80	Mainframes Other Models		
No. of User Responses	13	141	48	11	20	22		
Avg. Life of System (months)	28.6	45.5	40.4	29.2	58.4	54.3		
Acquisition Method (%)								
Purchase	38.46	53.19	27.08	27.27	31.58	57.14		
Rental or Lease from Mfr.	30.77	24.11	60.42	63.64	63.16	33.33		
Lease from 3rd Party	30.77	22.70	12.50	9.09	5.26	9.52		
Principal Applications (%)								
Accounting/Billing	76.92	66.67	93.75	81.82	75.00	50.00		
Banking—Check Processing/Loans/Savings	7.69	31.91	2.08	9.09	0.00	4.55		
Construction/Architecture	7.69	0.00	12.50	9.09	5.00	0.00		
Education—Scheduling/Administration	15.38	11.35	14.58	9.09	10.00	36.36		
Engineering/Scientific	15.38	1.42	14.58	18.18	45.00	27.27		
Health Care/Medical	23.08	8.51	8.33	18.18	5.00	18.18		
Insurance	7.69	2.13	6.25	9.09	15.00	0.00		
Manufacturing	23.08	11.35	29.17	36.36	15.00	18.18		
Mathematics/Statistics	15.38	3.55	8.33	18.18	35.00	13.64		
Order Processing/Inventory Control	53.85	45.39	70.83	54.55	35.00	31.82		
Payroll/Personnel	69.23	67.38	77.08	54.55	50.00	45.45		
Petroleum/Fuel Analysis	0.00	2.13	2.08	9.09	10.00	0.00		
Process Control	7.69	4.96	2.08	9.09	5.00	0.00		
Purchasing	30.77	30.50	50.00	27.27	50.00	13.64		
Sales/Distribution	30.77	31.21	50.00	36.36	20.00	13.64		
Other	23.08	10.64	6.25	18.18	30.00	27.27		
Source of Applications Programs (%)								
In-house Personnel	100.00	85.11	97.92	90.91	100.00	90.91		
"Packaged" Programs from Manufacturer	30.77	60.99	54.17	54.55	45.00	50.00		
Contract Programming	38.46	17.02	20.83	9.09	15.00	22.73		
Manufacturer's Personnel	0.00	4.96	25.00	18.18	0.00	13.64		
Independent Suppliers	30.77	38.30	35.42	18.18	30.00	45.45		
Using Data Base Management System (%)	75.00	34.53	72.92	90.91	95.00	54.55		
Planning a Data Base Management System in 1984	0.00	17.27	2.08	0.00	0.00	18.18		
Manufacturer's Package	0.00	0.00	100.00	90.00	78.94	33.33		
Outside Vendor's Package	100.00	72.92	0.00	0.00	5.26	8.33		
Using Communications Monitor (%)	61.54	48.91	53.19	54.55	47.37	42.86		
Planning a Communications Monitor in 1984	15.38	12.41	6.38	18.18	5.26	9.52		
Manufacturer's Package	0.00	8.96	76.00	50.00	44.44	33.33		
Outside Vendor's Package	75.00	38.81	0.00	0.00	0.00	0.00		
Using Integrated Office Automation Functions (%)	16.67	9.09	19.15	9.09	30.00	22.73		
Planning Office Automation Functions in 1984	16.67	21.97	29.79	45.45	20.00	13.64		
Have a Disaster Recovery Plan (%)	41.67	59.29	38.30	70.00	45.00	50.00		
Plan to in 1984	16.67	18.57	29.79	30.00	35.00	13.64		

User Ratings of Mainframes

Table 1. MAINFRAMES

NAS AS/6000, AS/7000, AS/9000	NCR 8400/8500/8600	Sperry 1100/60	Sperry 1100/70	Sperry 1100/80	Mainframes Other Models			Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
7.69	43.97	52.08	54.55	50.00	63.64			Additional Software from the Manufacturer
76.92	61.70	39.58	27.27	40.00	50.00			Proprietary Software from Other Suppliers
76.92	62.41	64.58	90.91	70.00	59.09			Expansions to Data Communications Facilities
15.38	26.95	27.08	36.36	50.00	22.73			Distributed Processing Capabilities
69.23	59.57	83.33	81.82	85.00	54.55			Expansions to Present Hardware
7.69	5.67	14.58	54.55	40.00	13.64			Business Graphics
15.38	12.77	8.33	9.09	10.00	18.18			Power Conditioning Systems
								System Ratings (4.0-1.0)
3.38	3.34	3.29	3.36	3.40	3.45			Ease of Operation
3.69	3.47	3.56	3.55	3.60	3.27			Reliability of Mainframe
3.42	3.33	3.23	3.36	3.10	3.09			Reliability of Peripherals
								Maintenance Service:
3.54	3.29	3.44	3.36	3.65	3.36			Responsiveness
3.46	3.10	3.23	3.27	3.30	3.18			Effectiveness
								Technical Support:
3.31	2.77	2.83	3.00	2.55	2.86			Trouble-shooting
3.00	2.91	2.62	2.55	2.60	2.82			Education
3.08	2.69	2.27	2.36	2.60	2.59			Documentation
								Manufacturer's Software:
3.30	3.21	3.40	3.36	3.50	3.41			Operating System
3.22	3.12	3.29	3.55	3.58	3.36			Compilers & Assemblers
3.33	2.54	2.57	2.89	2.58	2.76			Applications Programs
3.33	2.98	3.10	3.55	3.11	3.23			Ease of Programming
3.22	3.12	2.64	3.09	3.00	2.89			Ease of Conversion
3.44	3.08	3.19	3.45	3.20	3.18			Overall Satisfaction
								Additional Ratings (4.0-1.0)
3.31	3.32	3.06	3.60	3.22	3.14			Ease of Reconfiguration
3.75	3.15	2.55	2.82	2.75	3.06			Compatibility of Hardware carried over from other systems
3.75	3.22	2.34	3.00	2.89	2.85			Compatibility of Programs/data carried over from other systems
3.31	3.06	2.94	3.00	3.00	2.86			Power/energy Efficiency
3.17	2.70	2.55	3.18	2.33	2.64			Productivity Aids help keep programming costs low
2.92	2.49	2.54	2.82	2.95	2.73			Software/Support promised by vendor
3.38	3.16	2.73	2.73	3.15	3.27			Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
3.08	2.89	2.94	2.91	2.85	3.09			Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
3.09	2.85	2.89	2.82	2.70	3.14			Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
92.31	92.20	91.67	90.91	100.00	95.45			Yes
7.69	2.84	2.08	9.09	0.00	0.00			No
0.00	4.96	6.25	0.00	0.00	4.55			Undecided
								Would you recommend system to another user? (%)
76.92	86.52	87.50	81.82	100.00	77.27			Yes
23.08	6.38	4.17	9.09	0.00	18.18			No
0.00	7.09	8.33	9.09	0.00	4.55			Undecided

User Ratings of Mainframes

TABLE 2. MAINFRAME VENDOR SUMMARIES

Manufacturer and Model / Survey Item	Amdahl	Burroughs	Digital Equipment	Honeywell	IBM	IPL	Magnuson	NAS
No. of User Responses	30	114	54	45	562	12	7	13
Avg. Life of System (months)	38.6	34.3	70.1	31.0	36.7	28.3	30.4	28.6
Acquisition Method (%)								
Purchase	43.33	55.26	84.62	57.78	50.54	33.33	50.00	38.46
Rental or Lease from Mfr.	26.67	32.46	1.92	24.44	16.96	66.67	33.33	30.77
Lease from 3rd Party	30.00	12.28	13.46	17.78	32.50	0.00	16.67	30.77
Principal Applications (%)								
Accounting/Billing	76.67	68.42	64.81	84.44	80.78	25.00	42.86	76.92
Banking—Check Processing/Loans/Savings	6.67	27.19	0.00	6.67	9.79	0.00	14.29	7.69
Construction/Architecture	6.67	0.88	5.56	6.67	2.49	8.33	0.00	7.69
Education—Scheduling/Administration	6.67	7.89	42.59	15.56	13.88	0.00	0.00	15.38
Engineering/Scientific	23.33	7.89	27.78	4.44	14.06	0.00	0.00	15.38
Health Care/Medical	20.00	13.16	7.41	6.67	7.47	0.00	0.00	23.08
Insurance	26.67	8.77	9.26	15.56	9.61	25.00	14.29	7.69
Manufacturing	23.33	16.67	9.26	20.00	30.25	16.67	0.00	23.08
Mathematics/Statistics	30.00	7.89	35.19	17.78	11.92	0.00	14.29	15.38
Order Processing/Inventory Control	36.67	42.11	29.63	51.11	55.34	33.33	14.29	53.85
Payroll/Personnel	76.67	64.04	55.56	64.44	64.41	41.67	28.57	69.23
Petroleum/Fuel Analysis	3.33	3.51	1.85	4.44	1.96	0.00	0.00	0.00
Process Control	3.33	3.51	0.00	4.44	6.76	0.00	0.00	7.69
Purchasing	20.00	30.70	31.48	31.11	41.81	16.67	0.00	30.77
Sales/Distribution	30.00	24.56	12.96	35.56	36.83	16.67	14.29	30.77
Other	13.33	15.79	14.81	11.11	13.35	41.67	42.86	23.08
Source of Applications Programs (%)								
In-house Personnel	93.33	85.96	98.15	100.00	95.37	100.00	100.00	100.00
"Packaged" Programs from Manufacturer	33.33	32.46	25.93	31.11	42.35	0.00	28.57	30.77
Contract Programming	43.33	18.42	11.11	24.44	25.98	16.67	28.57	38.46
Manufacturer's Personnel	3.33	1.75	1.85	11.11	2.31	0.00	0.00	0.00
Independent Suppliers	40.00	49.12	51.85	35.56	45.91	8.33	57.14	30.77
Using Data Base Management System (%)	79.31	54.39	57.41	71.11	50.27	16.67	14.29	75.00
Planning a Data Base Management System in 1984	0.00	15.79	11.11	11.11	10.02	16.67	14.29	0.00
Manufacturer's Package	0.00	85.48	16.13	100.00	56.16	0.00	0.00	0.00
Outside Vendor's Package	95.65	0.00	45.16	0.00	31.52	100.00	100.00	100.00
Using Communications Monitor (%)	80.00	34.55	16.33	43.90	74.91	75.00	42.86	61.54
Planning a Communications Monitor in 1984	0.00	7.27	2.04	9.76	6.00	0.00	0.00	15.38
Manufacturer's Package	0.00	63.16	12.50	0.00	83.01	0.00	0.00	0.00
Outside Vendor's Package	83.33	0.00	0.00	0.00	8.25	66.67	66.67	75.00
Using Integrated Office Automation Functions (%)	23.33	7.34	27.45	11.36	11.11	8.33	0.00	16.67
Planning Office Automation Functions in 1984	26.67	21.10	23.53	11.36	22.03	0.00	16.67	16.67
Have a Disaster Recovery Plan (%)	66.67	50.00	47.17	33.33	50.72	18.18	71.43	41.67
Plan to in 1984	16.67	25.00	15.09	37.78	20.68	27.27	14.29	16.67

User Ratings of Mainframes

TABLE 2. MAINFRAME VENDOR SUMMARIES

Amdahl	Burroughs	Digital Equipment	Honeywell	IBM	IPL	Magnuson	NAS	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
50.00	38.60	22.22	55.56	55.34	16.67	0.00	7.69	Additional Software from the Manufacturer
83.33	42.11	40.74	46.67	65.30	75.00	57.14	76.92	Proprietary Software from Other Suppliers
76.67	65.79	51.85	73.33	64.23	75.00	57.14	76.92	Expansions to Data Communications Facilities
26.67	27.19	22.22	24.44	24.38	16.67	14.29	15.38	Distributed Processing Capabilities
76.67	57.02	59.26	53.33	65.30	58.33	71.43	69.23	Expansions to Present Hardware
13.33	14.04	16.67	8.89	13.52	8.33	14.29	7.69	Business Graphics
6.67	8.77	12.96	11.11	8.72	0.00	28.57	15.38	Power Conditioning Systems
								System Ratings (4.0-1.0)
3.43	3.73	3.62	3.27	3.18	3.58	3.43	3.38	Ease of Operation
3.57	3.42	3.35	3.45	3.72	3.75	3.57	3.69	Reliability of Mainframe
3.38	3.07	3.15	3.32	3.47	3.17	3.57	3.42	Reliability of Peripherals
								Maintenance Service:
3.83	3.28	3.40	3.39	3.47	3.08	3.71	3.54	Responsiveness
3.60	3.15	3.25	3.07	3.45	3.33	3.43	3.46	Effectiveness
								Technical Support:
3.47	2.85	3.00	2.86	3.08	3.25	2.86	3.31	Trouble-shooting
3.27	2.67	2.67	2.70	2.99	2.80	2.00	3.00	Education
3.03	2.53	2.81	2.51	2.88	3.00	2.29	3.08	Documentation
								Manufacturer's Software:
3.12	3.75	3.52	3.20	3.20	3.38	3.20	3.30	Operating System
3.11	3.35	3.36	3.23	3.30	3.56	3.20	3.22	Compilers & Assemblers
2.85	2.74	2.85	2.49	2.87	3.13	2.67	3.33	Applications Programs
2.78	3.44	3.39	3.07	2.94	3.00	3.00	3.33	Ease of Programming
2.90	3.30	3.06	2.88	2.88	2.86	3.00	3.22	Ease of Conversion
3.14	3.32	3.31	3.05	3.17	3.25	3.33	3.44	Overall Satisfaction
								Additional Ratings (4.0-1.0)
3.45	3.45	3.20	3.19	3.07	3.27	3.17	3.31	Ease of Reconfiguration
3.69	3.06	3.27	2.53	3.21	3.50	3.80	3.75	Compatibility of Hardware carried over from other systems
3.72	3.11	2.98	2.77	3.17	3.30	3.20	3.75	Compatibility of Programs/data carried over from other systems
3.19	3.19	2.52	3.00	3.21	3.60	3.17	3.31	Power/energy Efficiency
2.95	2.94	2.63	2.52	2.72	2.88	2.50	3.17	Productivity Aids help keep programming costs low
3.30	2.73	2.58	2.72	2.89	2.60	2.00	2.92	Software/Support promised by vendor
3.13	3.30	2.85	3.05	2.85	2.60	3.33	3.38	Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
3.03	2.82	2.90	2.98	3.02	3.00	2.86	3.08	Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
3.08	2.89	2.75	2.82	2.98	2.89	3.00	3.09	Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
100.00	94.69	90.74	97.78	98.58	100.00	100.00	92.31	Yes
0.00	3.54	3.70	2.22	0.36	0.00	0.00	7.69	No
0.00	1.77	5.56	0.00	1.07	0.00	0.00	0.00	Undecided
								Would you recommend system to another user? (%)
96.67	93.69	79.63	80.00	95.90	91.67	57.14	76.92	Yes
3.33	2.70	12.96	6.67	1.25	8.33	14.29	23.08	No
0.00	3.60	7.41	13.33	2.85	0.00	28.57	0.00	Undecided

User Ratings of Mainframes

TABLE 2. MAINFRAME VENDOR SUMMARIES

Survey Item / Manufacturer and Model	NCR	Sperry	Other Mainframes					
No. of User Responses	141	79	22					
Avg. Life of System (months)	45.5	43.6	54.3					
Acquisition Method (%)								
Purchase	53.19	28.21	57.14					
Rental or Lease from Mfr.	24.11	61.54	33.33					
Lease from 3rd Party	22.70	10.26	9.52					
Principal Applications (%)								
Accounting/Billing	66.67	87.34	50.00					
Banking—Check Processing/Loans/Savings	31.91	2.53	4.55					
Construction/Architecture	0.00	10.13	0.00					
Education—Scheduling/Administration	11.35	12.66	36.36					
Engineering/Scientific	1.42	22.78	27.27					
Health Care/Medical	8.51	8.86	18.18					
Insurance	2.13	8.86	0.00					
Manufacturing	11.35	26.58	18.18					
Mathematics/Statistics	3.55	16.46	13.64					
Order Processing/Inventory Control	45.39	59.49	31.82					
Payroll/Personnel	67.38	67.09	45.45					
Petroleum/Fuel Analysis	2.13	5.06	0.00					
Process Control	4.96	3.80	0.00					
Purchasing	30.50	46.84	13.64					
Sales/Distribution	31.21	40.51	13.64					
Other	10.64	13.92	27.27					
Source of Applications Programs (%)								
In-house Personnel	85.11	97.47	90.91					
"Packaged" Programs from Manufacturer	60.99	51.90	50.00					
Contract Programming	17.02	17.72	22.73					
Manufacturer's Personnel	4.96	17.72	13.64					
Independent Suppliers	38.30	31.65	45.45					
Using Data Base Management System (%)	34.53	81.01	54.55					
Planning a Data Base Management System in 1984	17.27	1.27	18.18					
Manufacturer's Package	0.00	92.19	33.33					
Outside Vendor's Package	72.92	1.56	8.33					
Using Communications Monitor (%)	48.91	51.95	42.86					
Planning a Communications Monitor in 1984	12.41	7.79	9.52					
Manufacturer's Package	8.96	65.00	33.33					
Outside Vendor's Package	38.81	0.00	0.00					
Using Integrated Office Automation Functions (%)	9.09	20.51	22.73					
Planning Office Automation Functions in 1984	21.97	29.49	13.64					
Have a Disaster Recovery Plan (%)	59.29	44.16	50.00					
Plan to in 1984	18.57	31.17	13.64					

User Ratings of Mainframes

TABLE 2. MAINFRAME VENDOR SUMMARIES

NCR	Sperry	Other Mainframes						Manufacturer and Model / Survey Item
43.97	51.90	63.64						Planned Acquisitions/Implementations for 1984 (%)
61.70	37.97	50.00						Additional Software from the Manufacturer
62.41	69.62	59.09						Proprietary Software from Other Suppliers
26.95	34.18	22.73						Expansions to Data Communications Facilities
59.57	83.54	54.55						Distributed Processing Capabilities
5.67	26.58	13.64						Expansions to Present Hardware
12.77	8.86	18.18						Business Graphics
								Power Conditioning Systems
								System Ratings (4.0-1.0)
3.34	3.33	3.45						Ease of Operation
3.47	3.57	3.27						Reliability of Mainframe
3.33	3.22	3.09						Reliability of Peripherals
								Maintenance Service:
3.29	3.48	3.36						Responsiveness
3.10	3.25	3.18						Effectiveness
								Technical Support:
2.77	2.78	2.86						Trouble-shooting
2.91	2.60	2.82						Education
2.69	2.37	2.59						Documentation
								Manufacturer's Software:
3.21	3.42	3.41						Operating System
3.12	3.40	3.36						Compilers & Assemblers
2.54	2.61	2.76						Applications Programs
2.98	3.17	3.23						Ease of Programming
3.12	2.78	2.89						Ease of Conversion
3.08	3.23	3.18						Overall Satisfaction
								Additional Ratings (4.0-1.0)
3.32	3.17	3.14						Ease of Reconfiguration
3.15	2.64	3.06						Compatibility of Hardware carried over from other systems
3.22	2.58	2.85						Compatibility of Programs/data carried over from other systems
3.06	2.96	2.86						Power/energy Efficiency
2.70	2.59	2.64						Productivity Aids help keep programming costs low
2.49	2.68	2.73						Software/Support promised by vendor
3.16	2.84	3.27						Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
2.89	2.91	3.09						Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
2.85	2.83	3.14						Delivery of required Software (ahead of schedule=4.0; very late=1.0)
92.20	93.67	95.45						Did the system do what you expected it to do? (%)
2.84	2.53	0.00						Yes
4.96	3.80	4.55						No
								Undecided
86.52	89.87	77.27						Would you recommend system to another user? (%)
6.38	3.80	18.18						Yes
7.09	6.33	4.55						No
								Undecided

User Ratings of Minicomputer Systems

This report presents the results of Datapro's 1984 survey of computer users. User experiences with over 1900 minicomputer systems have been summarized and are presented in the accompanying tables. These user ratings evaluate the performance, reliability, and vendor support for the most popular minicomputers sold today. The information provided by the actual users of these systems can aid a prospective user in the evaluation of a minicomputer acquisition.

Datapro is pleased to present, in conjunction with *Computerworld*, the 1984 edition of the annual Computer Users Survey. This year's survey is based on responses to questionnaires mailed to a cross-section of computer sites listed with International Data Corporation (IDC). This report summarizes the results received from minicomputer users. For the results of the mainframe users polled, please reference *DATAPRO 70*. The users were asked to rate their systems in 25 subjective categories and respond to a variety of questions covering such areas as system configuration, languages, data base management, and whether they would recommend the system to another user.

Our purpose in using IDC's list of known computer sites was twofold: to select only currently marketed system models, and to improve the results for those models. The number of responses received for models which are no longer in production, like the IBM System/370 or IBM System/3, was dramatically reduced. In addition, the number of responses received for the systems we selected increased over last year's responses in over 50 percent of the cases. Some of those increases were rather dramatic; we received over 200 percent more responses for the Wang VS and 134 percent more for the DEC VAX systems. By using IDC's list, we received responses for systems recently introduced, also. Nine users of the IBM 4361/4381, delivered for the first time early in 1984, responded to our questionnaire, and over 60 responses came in for the IBM System/36, delivered for the first time in the late summer of 1983. The NCR 9300 and Sperry 1100/70 were also included in the survey for the first time.

We would like to stress that individual profiles or ratings should never be the major consideration in making an acquisition decision. The reader can use the material in this report to help formulate questions about a computer system as the evaluation process proceeds. The information within this report is very informative if used with discretion and with the understanding that there are many factors involved in selecting the right computer system to meet your particular needs.

SURVEY METHODOLOGY

The 1984 survey has been based on results received from 15,000 questionnaires mailed to known computer sites listed with IDC. The total number of questionnaires was divided into two groups: 9000 surveys were mailed to minicomputer users and 6000 to mainframe users. In addition, the sites were chosen based on the computer system they had installed. Datapro supplied IDC with a list of specific system models to be included in the mailing and the model was listed directly on the mailing label. In an effort to improve the response rate and thereby increase the statistical validity, the users were contacted twice; a first request was followed two weeks later by a second request.

Each questionnaire allowed the user to rate one computer system and specifically requested that the rating apply to the system listed on the label. The recipient was encouraged to reproduce the form if he/she wished to rate additional systems. The IDC labels were used as initial validation vehicles and for identification and elimination of invalid and duplicate returns. All returns were analyzed by senior Datapro analysts and some returns were judged invalid for one or more of the following reasons: more than one system model was rated on a single form; the response was a duplicate; the form was received after the deadline; the ratings section of the questionnaire was not completed; the systems rated were not mainframe or minicomputer systems; or the response revealed a vested interest on the part of the respondent. In addition, system models receiving less than five responses were not included in the final analysis, although the responses were considered to be valid.

Of the 15,000 questionnaires mailed, 3404 responses were received from 3261 respondents, a return of 22 percent on the total mailing. Of the total responses, 352 were judged to be invalid, giving us 3052 valid responses from 2909 users. Of these valid responses, 1079 rated mainframe computer systems, for a return of 18 percent on the 6000 surveys mailed to mainframe users, and 1973 rated minicomputer systems, for a return of 22 percent on the 9000 surveys mailed to minicomuter users.

Datapro batched the valid returns by manufacturer and model and sent the returns to Mathematica Policy Research, Inc. for tabulation of the results. The summary information was prepared in the form of either averages, percentages, or weighted averages. Weighted averages were computed in a manner similar to most college grading systems: "Excellent" is weighted as 4, "Good" as 3, "Fair" as 2, and "Poor" as 1. The tallied numbers for each value are then multiplied by the corresponding weight, and the average is taken by dividing the sum of the products by the total number of responses for that category.

THE 1984 QUESTIONNAIRE

Users were asked to answer 27 multiple-part questions. Each user was asked to identify the manufacturer and model of their system, as well as the month and year of acquisition, and method of acquisition. Users were requested to identify the type of industry their company was in. ▷

User Ratings of Minicomputer Systems

Chart 1. Usage of Local and Remote Workstations/Terminals

Manufacturer & Model / No. of Workstations/ Terminals per System	Local						Remote					
	None	1-5	6-15	16-30	31-60	Over 60	None	1-5	6-15	16-30	31-60	Over 60
Burroughs:												
B 1800	0	1	3	0	1	0	1	2	1	1	0	0
B 90	1	15	2	0	0	0	15	1	0	0	0	0
B 900	0	1	2	1	0	1	1	2	2	0	0	0
B 1900	1	30	53	43	14	2	47	34	29	16	8	5
Data General:												
CS Series	0	10	8	5	0	0	17	3	1	2	0	0
Eclipse	1	16	16	16	2	4	27	20	8	0	1	0
Eclipse/MV	0	0	13	14	11	5	8	13	7	9	5	1
Datapoint, all models	1	5	17	9	2	0	18	8	3	2	1	0
Digital Equipment:												
PDP-11	0	13	50	36	26	12	31	58	25	12	10	0
VAX-11	0	11	55	65	73	37	44	79	48	24	16	20
Four-Phase, all models	0	3	15	7	5	1	24	4	1	0	1	0
Harris, all models	0	1	3	2	0	1	1	1	0	0	2	3
Hewlett-Packard:												
1000	0	6	2	1	0	0	5	3	1	0	0	0
3000	0	8	47	52	40	8	41	58	29	14	11	2
Honeywell DPS6	0	6	13	9	4	1	16	13	3	0	0	1
IBM:												
Series 1	0	7	8	0	0	0	6	8	0	0	0	0
System/23	0	13	0	0	0	0	13	0	0	0	0	0
System/34	0	58	80	9	0	0	99	39	4	0	0	0
System/36	0	16	38	11	2	0	38	18	8	2	0	0
System/38	0	7	75	88	44	8	80	62	45	21	7	5
8100	0	0	3	0	2	0	5	0	0	1	0	0
MAI/Basic Four, all models	0	2	3	5	2	0	2	7	2	1	0	0
MDS/Qantel, all models	0	4	9	5	0	0	10	6	0	0	0	0
Microdata:												
Reality	0	9	36	7	4	0	26	23	4	2	0	0
Sequel	0	0	0	8	12	1	5	7	2	5	1	0
NCR:												
9000	0	23	29	9	5	1	36	18	6	3	1	0
9300	0	5	8	0	0	0	5	6	2	0	0	0
Perkin-Elmer 3200	0	4	11	2	3	1	6	6	5	2	1	1
Prime 50 Series	0	4	26	34	37	15	27	31	19	20	7	8
Sperry System 80	1	9	37	10	1	1	33	11	9	1	0	1
Wang VS	0	21	56	32	20	4	60	57	6	5	3	0
Other Minicomputers	1	16	15	3	5	2	15	14	6	1	0	3
All Minicomputers	6	324	733	483	315	105	762	612	276	144	75	50

principal applications, and the source of those applications programs. We also asked the users for information about their hardware and software configurations, and about acquisitions or implementations planned for 1984.

The remaining questions asked the users to rate various aspects of their computer systems. The categories rated included: ease of operation, reliability of system, reliability of peripherals, maintenance service (responsiveness and effectiveness), technical support (troubleshooting, education, and documentation), manufacturer's software (operating system, compilers and assemblers, and application programs), ease of programming, ease of conversion, and overall satisfaction. Additional ratings added this year included: ease of reconfiguration, compatibility of terminals, peripherals, and software carried over from other systems, power/energy efficiency, productivity aids, software/support promised by the vendor, delivery of hardware and required software, noise level of equipment, and how easy or difficult was it to keep up with and implement vendor changes to hardware/software. In addition, if utilizing a data base management system or communications monitor, the user was asked to identify the vendor and package, and to rate the technical support and their overall satisfaction with the package.

Finally, the user was asked whether the computer system did what it was expected to do, and whether they would recommend their computer system to another user.

SURVEY RESULTS

Table 1 summarizes the results of the 1975 responses received from minicomputer users. Thirty-one system

User Ratings of Minicomputer Systems

Manufacturer	Number Installed
Apple	3966
IBM	3177
DEC	1440
Radio-Shack	743
Hewlett-Packard	716
Data General	576
Burroughs	371
Texas Instruments	280
NCR	104
Honeywell	36

Chart 2. Number of microcomputers installed at respondent's sites.

models from 17 minicomputer manufacturers are represented in the table. Table 2, "Minicomputer Vendor Summaries," contains the same results as Table 1, summarized by manufacturer.

Hardware Configurations

Forty percent of the users reported memory capacities of between 512KB and one megabyte; 22 percent reported from one to two megabytes; 21 percent reported from two to four megabytes of memory and the remaining 17 percent reported memory capacities of over four megabytes. The majority of the users (43 percent) have between 100 and 600 megabytes of disk storage and another 37 percent reported over 600 megabytes of total disk storage.

We also asked the users how many local workstations/terminals and how many remote workstations/terminals they were using. Chart 1 shows the usage of local and remote terminals by manufacturer and model. Approximately 37 percent were using between 6 and 15 local terminals, another 25 percent had between 16 and 30 local terminals, and 21 percent were using over 31 local terminals. The majority of users (40 percent) had no remote terminals. Thirty-two percent were using between 1 and 5 remote terminals, another 14 percent had between 6 and 15 remote terminals, and 14 percent were using over 16 remote terminals.

Asked for the first time this year was a question on the number of microcomputers installed at the user's site. We wanted to see just how widespread the use of micros is in the business world and which micros are the most popular. While Apple is still leading, it seems certain that IBM will catch up or probably surpass Apple as the leading micro in next year's survey.

There are so many Apple and IBM microcomputers installed that we thought it would be interesting to see if they were being used by certain sites. Chart 3 shows the percentage of the total Apple and IBM micros installed at sites with specific vendor's systems. DEC users have the largest percentage of the Apples installed and specifically, 35 percent of the Apples are installed by VAX users. Notice, also,

Mini Installed	APPLE	IBM
Burroughs	18%	5%
DEC	47%	30%
Data General	4%	3%
Hewlett-Packard	8%	9%
IBM	6%	26%
Microdata	—	8%
NCR	3%	—
Prime	9%	8%
Wang	—	4%

Chart 3. Pecentage of total Apple or IBM microcomputers installed by users with a particular vendor's mini.

Chart 4. Computer Usage by Manufacturer and Industry Type

Manufacturer \ Type of Industry	Banking/Finance/ Securities	Chemical/ Petroleum	Construction	Education	Engineering/ Scientific	Government	Health Care/ Medical	Insurance	Legal	Manufacturing	Media	Public Accounting/ Consulting	Retail/Wholesale	Service Bureau	Transportation	Utilities (Public)	Other
Burroughs (171)	12.28	2.34	1.75	12.28	0.58	11.11	5.26	2.92	0.00	23.39	0.58	2.34	11.70	4.09	1.75	1.17	6.43
Data General (120)	5.00	1.67	1.67	3.33	5.00	6.67	13.33	2.50	3.33	15.83	0.83	2.50	12.50	10.00	1.67	0.00	14.17
Datapoint (34)	14.71	5.88	0.00	2.94	2.94	2.94	0.00	2.94	0.00	14.71	2.94	0.00	0.00	20.59	11.76	0.00	17.65
Digital Equipment (378)	2.12	2.12	0.79	28.31	12.17	4.76	5.29	0.53	0.79	15.34	1.59	1.85	5.29	4.50	0.79	1.59	12.17
Four-Phase (31)	6.45	0.00	0.00	3.23	0.00	16.13	48.39	3.23	3.23	9.68	0.00	0.00	0.00	0.00	0.00	0.00	9.68
Harris (7)	0.00	0.00	0.00	57.14	0.00	14.29	0.00	0.00	0.00	14.29	0.00	0.00	0.00	0.00	0.00	14.29	0.00
Hewlett-Packard (165)	1.82	4.24	0.61	13.33	4.24	9.70	2.42	0.61	0.61	27.88	1.82	1.21	7.27	5.45	2.42	0.61	15.76
Honeywell (33)	12.12	0.00	3.03	0.00	0.00	12.12	9.09	3.03	0.00	27.27	0.00	0.00	21.21	0.00	0.00	0.00	12.12
IBM (471)	4.67	2.55	2.55	4.25	0.64	5.52	3.82	2.76	0.85	33.76	1.49	2.97	16.99	2.97	2.12	1.27	10.83
MAI/Basic Four (12)	8.33	0.00	16.67	0.00	0.00	0.00	0.00	0.00	0.00	16.67	0.00	8.33	33.33	0.00	0.00	0.00	16.67
MDS/Qantel (18)	0.00	0.00	5.56	0.00	0.00	0.00	11.11	0.00	0.00	38.89	0.00	0.00	11.11	0.00	0.00	0.00	33.33
Microdata (78)	2.56	1.28	3.85	1.28	0.00	7.69	7.69	2.56	1.28	23.08	0.00	5.13	24.36	1.28	1.28	1.28	15.38
NCR (79)	5.06	0.00	3.80	10.13	0.00	6.33	15.19	0.00	1.27	26.58	2.53	1.27	16.46	3.80	1.27	0.00	6.33
Perkin-Elmer (21)	4.76	0.00	0.00	4.76	9.52	4.76	9.52	4.76	0.00	19.05	0.00	0.00	14.29	14.29	4.76	0.00	9.52
Prime (116)	2.59	1.72	4.31	17.24	16.38	4.31	1.72	1.72	0.00	15.52	0.00	3.45	5.17	6.03	1.72	5.17	12.93
Sperry (59)	1.69	0.00	1.69	8.47	0.00	10.71	5.08	3.39	0.00	33.90	1.69	0.00	18.64	3.39	1.69	1.69	8.47
Wang (135)	2.22	4.44	1.48	5.19	0.74	8.15	4.44	2.22	5.19	27.41	0.74	2.22	7.41	7.41	1.48	0.00	19.26
Other (42)	7.14	0.00	0.00	9.52	4.76	0.00	7.14	0.00	0.00	9.52	0.00	2.38	14.28	19.05	2.38	0.00	23.81
All Minicomputers (1970)	4.52	2.23	1.98	11.47	4.47	6.70	6.14	1.88	1.17	23.91	1.17	2.23	11.57	5.08	1.78	1.22	12.54

User Ratings of Minicomputer Systems

that a higher percentage of the IBM micros are installed by DEC users than by IBM users. The number of micros installed by sites using mini vendor's systems not listed were less than one percent each.

Industry and Applications

One of the questions we asked the users was "what type of industry describes your company?" Chart 4 shows the market penetration in each industry by manufacturer.

We also asked the users to specify their principal applications. Since 1982 the top six applications have remained the same: accounting/billing, payroll/personnel, order processing/inventory control, sales/distribution, purchasing, and manufacturing. Chart 5 compares the user rankings of principal applications from 1983 and 1984. This year, education moved up from tenth to seventh place.

1984 Rankings	1983 Rankings
1. Accounting/Billing	1. Accounting/Billing
2. Payroll/Personnel	2. Payroll/Personnel
3. Order Processing/Inv. Control	3. Order Processing/Inv. Control
4. Sales/Distribution	4. Sales/Distribution
5. Purchasing	5. Purchasing
6. Manufacturing	6. Manufacturing
7. Education	7. Engr./Scientific
8. Engineering/Scientific	8. Math./Statistics
9. Math./Statistics	9. Health Care/Medical
10. Health Care/Medical	10. Education

Chart 5. User rankings of principal applications.

Software

The computer application development life cycle is a highly labor-intensive cycle. As labor costs climb, so does the cost of software development. As computers increase in capability and speed and as users become accustomed to results, the clamor for additional applications for "the computer" increases. Since many systems already face a two-year backlog in bringing up desirable applications, it is becoming more and more common for users to seek multiple sources for applications programs. And as the proprietary software industry increases in maturity and sophistication, "packaged software" becomes a desirable adjunct to in-house development.

We asked the users how they acquired their software, specifically, their application software. The 1984 user rankings of sources of applications programs compared with the 1983 rankings appear in Chart 6. Notice that programs from independent suppliers has moved up to position two, shoving the manufacturer's packages down one notch to position three.

1984	1983
1. In-house Personnel	1. In-house Personnel
2. Independent Supplier	2. Packaged Programs from Mfg
3. Packaged Programs from Mfg	3. Independent Supplier
4. Contract Programming	4. Contract Programming
5. Manufacturer's Personnel	5. Manufacturer's Personnel

Chart 6. User rankings of sources of applications programs.

Another important question concerning software is "which programming language should I use?" Chart 7 illustrates which languages are used most frequently by minicomputer sites. This year Cobol comes out on top as the most frequently used language, followed by RPG (the primary language for IBM minis), and Basic.

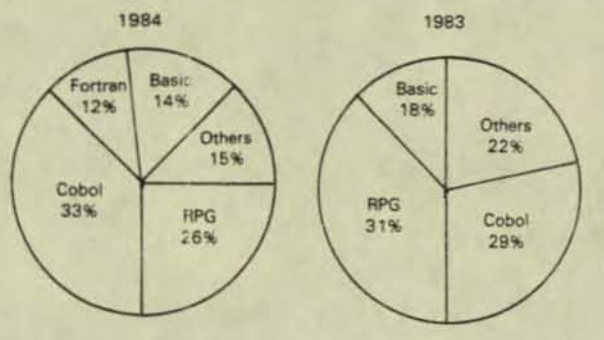

Chart 7. Primary programming languages

On the 1983 survey we asked if a data base management system and communications monitor were being used and if it was the manufacturer's package or an outside vendor's package. This year we took these questions a step farther and asked the user to name the package and then to assign a rating of Excellent, Good, Fair, or Poor to the package. Chart 8 shows the most widely used data base management packages, the number of responses received and the ratings for technical support (troubleshooting, documentation, and education), and the user's overall satisfaction with the package. Because so many different packages are available, we limited the following list to packages which received at least 10 responses.

Vendor and Package	Technical Support	Overall Satisfaction	No. Responses
Burroughs DMS-II	3.01	3.49	128*
Cincom Total	3.03	3.06	62*
DEC Datatrieve	2.94	2.94	18*
DEC DBMS	2.65	2.82	17*
Data General Infos	2.60	2.87	15
Honeo Info	2.68	3.00	22
Hewlett-Packard Image	3.31	3.45	124
IBM CPF	3.39	3.61	62
Microdata Reality	3.00	3.50	14
Poise DMS	3.20	3.30	10
Prime Information	2.82	3.41	17

*Chart 8. Data Base Management Packages. *Count includes both minicomputer and mainframe users.*

Communications monitors are not yet as prevalent on minicomputers as data base packages. Only two packages received more than 10 responses—Burroughs' MCS with 25 responses and Burroughs' NDL with 12 responses (these counts include both minicomputer and mainframe users). The ratings for the two monitors were very close. MCS received a weighted average rating of 3.00 for technical support, while NDL received a rating of 2.92. For overall satisfaction, MCS earned a 3.32 rating and NDL received a 3.42 rating.

User Ratings of Minicomputer Systems

Financial Alternatives

Users have three options by which they can acquire their computer system: purchase, rent/lease from the manufacturer, or lease from a third party. Each method of acquisition offers its own benefits and each method should be examined carefully to see which of these methods would be most beneficial to your company. By using the purchase option, the user can enjoy benefits such as the investment tax credit and depreciation schedule allowances. With the rapid advances in technology, however, many users feel that rental/lease from the manufacturer is the best option for them—because it allows them to upgrade faster to new systems. Also, many vendors include maintenance in the rent/lease price. The advantages a user can receive from third-party leasing are faster delivery and more attractive lease prices.

One of the questions we asked, therefore, was how users acquired their systems: outright purchase, rental/lease from the manufacturer, or third-party lease. Chart 9 shows how minicomputer users have acquired their systems for the last three years.

Method of Acquisition	1984	1983	1982
Purchase (%)	68	70	63
Rent/lease from Mfg.(%)	16	16	25
Lease from 3rd Party (%)	16	14	12

Chart 9. Financial alternatives.

Aquisitions and Replacements

We asked how users were planning on spending their enhancement/acquisition dollars in 1984. Chart 10 compares the user rankings of planned acquisitions for 1983 and 1984. Undoubtedly due to the increasing importance being placed on communications among systems and users, expansions to data communication facilities moved up from third to second place this year.

1984 Planned Acquisitions	1983 Planned Acquisitions
1. Expansions to Present Hardware (65%)	1. Expansions to Present Hardware (44%)
2. Expansions to Data Communications (44%)	2. Additional Proprietary Software (34%)
3. Additional Proprietary Software (41%)	3. Expansions to Data Communications (29%)
4. Additional Software from Mfg. (30%)	4. Additional Software from Mfg. (24%)
5. Additions to Distributed Processing Capabilities (15%)	5. Implement Disaster Recovery Plan (15%)

Chart 10. User rankings of planned acquisitions in 1984.

Disaster Recovery

The increasing dependence on computers has made many organizations aware of the vulnerability of their computer installations in the event of a fire, flood, or other disaster. We wanted to know how many survey respondents had implemented a disaster recovery plan and how many others were planning on doing so. Our survey shows that disaster recovery plans have been implemented by 51 percent of the minicomputer users. Interestingly, this is the same percentage reported last year by mini users. Plans to implement a disaster recovery plan were reported by 17 percent of the users, up slightly from the 15 percent reported in 1983.

Office Automation

The integrated office system is one that ties together discrete pieces of office equipment to make information more widely and easily accessible to the people who have a need for that information. Office automation is not longer geared solely toward clerks and typists. Today, office automation benefits employees at all levels in a company by providing a wide range of functions such as data processing, word processing, electronic mail, voice capabilities, business graphics, teleconferencing, image processing, and local area communications. To see how this trend toward the integrated office is shaping up, we asked the users whether they use integrated office functions or plan to in 1984. Thirty-three percent of the users have already made a commitment to the integrated office and another 17 percent plan to implement these functions in 1984. So a full 50 percent of the minicomputer users are working towards integrating their office functions.

User Satisfaction Ratings

Consistent with our belief that what users think is extremely important, we asked users to rate their computer systems and the associated software and vendor support by assigning a rating of Excellent, Good, Fair, or Poor to each of 14 factors: ease of operation, reliability of mainframe, reliability of peripherals, maintenance service (responsiveness and effectiveness), technical support (troubleshooting, education, and documentation), manufacturer's software (operating system, compilers and assemblers, and applications programs), ease of programming, ease of conversion, and overall satisfaction. All ratings are expressed in terms of Weighted Averages, which were calculated by assigning a weight of 4 to each user rating of Excellent, 3 to Good, 2 to Fair, and 1 to Poor, and then dividing the sum by the number of users who rated each factor.

The individual responses by vendor model appear in Table 1. In analyzing the ratings, we decided to see how many systems could meet the following criteria for special merit: a minimum of 20 user responses, an overall satisfaction

	Overall Satisfaction	Lowest Score	No. of Responses
Data General MV	3.31	2.86	43
DEC VAX-11	3.42	2.91	242
HP 3000	3.47	2.94	157
IBM System/34	3.35	2.90	148
IBM System/36	3.57	3.08	67
IBM System/38	3.47	2.83	222

Chart 11. Systems of special merit.

User Ratings of Minicomputer Systems

rating of at least 3.20, and a rating of no less than 2.80 in all other system rating categories. Chart 11 lists the six minicomputer systems that met this criteria.

For a number of other categories, we selected those systems that received a minimum of 20 responses and a rating of at least 3.50. Charts 12-14 show the systems that met these criteria for ease of operation, reliability of system and peripherals, and operating system.

Ease of Operation	Weighted Average	No. of Responses
Burroughs B 1900	3.55	143
DEC VAX-11	3.53	242
IBM System/36	3.63	67
Microdata Reality	3.63	57
Microdata Sequel	3.71	21
Wang VS	3.74	135

Chart 12. Systems given 3.50 rating for ease of operation.

Reliability of System	Weighted Average	No. of Responses
Data General Eclipse	3.56	56
DEC PDP-11	3.55	137
DEC VAX-11	3.58	242
HP 3000	3.70	157
IBM System/34	3.84	148
IBM System/36	3.75	67
IBM System/38	3.75	222
NCR 9000	3.55	67
Perkin-Elmer 3200	3.52	21
Prime 50 Series	3.60	116
Wang VS	3.74	135
Reliability of Peripherals		
HP 3000	3.70	157
IBM System/34	3.83	148
IBM System/36	3.75	67
IBM System/38	3.75	222
NCR 9000	3.50	67

Chart 13. Reliability of system and peripherals.

Operating System	Weighted Average	No. of Responses
Burroughs B 1900	3.57	143
DEC VAX-11	3.52	242
IBM System/36	3.54	67
IBM System/38	3.55	222
Microdata Reality	3.66	57
Microdata Sequel	3.75	21

Chart 14. Systems with a 3.50 rating for operating system.

Vendor service and support are key areas when considering a computer system. Although users have no control over the effectiveness of maintenance service, they can influence promptness of maintenance service by spelling out their requirements in their contract with the vendor. Chart 15 lists those vendors that received the highest overall ratings for maintenance service and technical support. To be listed in this chart, the vendor had to have a minimum of 20 user responses and a rating of at least 3.50 for maintenance service and 3.00 for technical support. Through the years that Datapro has been conducting this survey, we have found that the area of technical support usually receives the lowest ratings from the users. We felt, therefore, that any vendor receiving a rating of 3.00 in technical support was deserving of special mention. No vendor received a 3.00 in all three areas of technical support; no vendor rated a 3.00 for education.

Maintenance Service	Weighted Average	No. of Responses
Responsiveness:		
Hewlett-Packard	3.54	166
NCR	3.56	80
Effectiveness:		
Hewlett-Packard	3.54	166
NCR	3.52	80
Technical Support		
Troubleshooting:		
Hewlett-Packard	3.17	166
IBM	3.04	471
Documentation:		
IBM	3.02	471

Chart 15. Vendors receiving highest ratings for service and support.

Expectations and Recommendations

We asked the computer users "Did the system do what you expected it to do?" Ninety-two percent answered "yes", four percent said "no", and another four percent said "haven't decided."

The final question on the survey asked the users whether they would recommend the system to another user. Eighty-nine percent answered they would recommend the system, five percent said they would not, and six percent were undecided. These responses represent a slight improvement over 1983, when only 86 percent answered they would recommend the system, 7 percent said they would not, and the remaining 7 percent were undecided.

THANK YOU

Datapro extends a sincere thanks to all for responding so enthusiastically to our 1984 survey of user experiences with computer systems. Without your participation the survey could not have been the success it is, and we hope that this compendium of the opinions of user colleagues will be of significant value to you. We look forward to hearing from you again next year. □

User Ratings of

Minicomputer Systems

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Survey Item / Manufacturer and Model	Burroughs B 1800	Burroughs B 90	Burroughs B 900	Burroughs B 1900	Data General CS Series	Data General Eclipse	Data General Eclipse/MV	Datapoint All Models
No. of User Responses	5	18	5	143	23	56	43	34
Avg. Life of System (months)	52.5	40.5	37.4	39.5	50.8	55.4	23.4	30.3
Acquisition Method (%)								
Purchase	60.00	77.78	60.00	50.70	82.61	85.71	81.40	64.71
Rental or Lease from Mfr.	20.00	5.56	40.00	40.85	0.00	1.79	2.33	26.47
Lease from 3rd Party	20.00	16.67	0.00	8.45	17.39	12.50	16.28	8.82
Principal Applications (%)								
Accounting/Billing	80.00	72.22	60.00	79.02	69.57	67.86	69.77	76.47
Banking—Check Processing/Loans/Savings	20.00	27.78	0.00	12.59	8.70	3.57	0.00	0.00
Construction/Architecture	0.00	0.00	0.00	1.40	0.00	8.93	0.00	0.00
Education—Scheduling/Administration	20.00	0.00	0.00	17.48	17.39	7.14	20.93	2.94
Engineering/Scientific	0.00	0.00	0.00	4.20	0.00	19.64	9.30	2.94
Health Care/Medical	0.00	11.11	20.00	8.39	17.39	21.43	4.65	5.88
Insurance	0.00	5.56	0.00	4.90	13.04	7.14	4.65	5.88
Manufacturing	60.00	0.00	0.00	20.98	8.70	12.50	16.28	11.76
Mathematics/Statistics	0.00	5.56	0.00	4.90	4.35	12.50	13.95	5.88
Order Processing/Inventory Control	80.00	38.89	40.00	46.15	34.78	41.07	51.16	41.18
Payroll/Personnel	60.00	55.56	60.00	72.03	39.13	42.86	48.84	47.06
Petroleum/Fuel Analysis	0.00	5.56	0.00	0.70	4.35	1.79	2.33	0.00
Process Control	20.00	0.00	0.00	2.10	0.00	3.57	2.33	8.82
Purchasing	60.00	27.78	60.00	38.46	13.04	21.43	30.23	17.65
Sales/Distribution	20.00	33.33	40.00	27.27	21.74	16.07	25.58	44.12
Other	0.00	22.22	40.00	16.08	13.04	32.14	27.91	17.65
Source of Applications Programs (%)								
In-house Personnel	80.00	16.67	60.00	81.12	78.26	66.07	86.05	94.12
"Packaged" Programs from Manufacturer	60.00	44.44	20.00	31.47	17.39	21.43	23.26	5.88
Contract Programming	0.00	11.11	40.00	27.97	34.78	28.57	32.56	32.35
Manufacturer's Personnel	0.00	16.67	0.00	3.50	0.00	1.79	2.33	0.00
Independent Suppliers	80.00	50.00	20.00	35.66	56.52	46.43	46.51	17.65
Using Data Base Management System (%)	60.00	11.11	0.00	52.45	15.79	35.71	41.46	8.82
Planning a Data Base Management System in 1984	20.00	11.11	20.00	18.88	15.79	8.93	17.07	11.76
Manufacturer's Package	100.00	0.00	0.00	100.00	100.00	100.00	100.00	0.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Using Communications Monitor (%)	0.00	0.00	25.00	23.91	5.26	5.66	17.95	9.09
Planning a Communications Monitor in 1984	0.00	0.00	0.00	3.62	10.53	1.89	12.82	0.00
Manufacturer's Package	0.00	0.00	0.00	95.46	0.00	0.00	0.00	0.00
Outside Vendor's Package	0.00	0.00	0.00	4.54	0.00	0.00	0.00	0.00
Using Integrated Office Automation Functions (%)	0.00	26.67	0.00	14.49	25.00	29.41	51.22	65.63
Planning Office Automation Functions in 1984	0.00	0.00	25.00	19.57	10.00	15.69	19.51	9.38
Have a Disaster Recovery Plan (%)	80.00	55.56	60.00	51.43	47.83	61.11	39.53	60.61
Plan to in 1984	0.00	0.00	0.00	15.71	13.04	14.81	27.91	6.06

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Burroughs B 1800	Burroughs B 90	Burroughs B 900	Burroughs B 1900	Data General CS Series	Data General Eclipse	Data General Eclipse/MV	Datapoint All Models	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
60.00	27.78	40.00	25.87	17.39	14.29	48.84	50.00	Additional Software from the Manufacturer
40.00	16.67	20.00	30.07	43.48	53.57	41.86	23.53	Proprietary Software from Other Suppliers
60.00	11.11	40.00	52.45	8.70	28.57	58.14	52.94	Expansions to Data Communications Facilities
20.00	5.56	40.00	21.68	8.70	17.86	9.30	17.65	Distributed Processing Capabilities
60.00	22.22	40.00	58.74	43.48	51.79	74.42	70.59	Expansions to Present Hardware
0.00	5.56	0.00	10.49	0.00	7.14	16.28	8.82	Business Graphics
0.00	0.00	0.00	8.39	8.70	25.00	18.60	5.88	Power Conditioning Systems
								System Ratings (4.0-1.0)
4.00	3.22	3.40	3.55	3.30	3.33	3.42	3.12	Ease of Operation
3.80	3.50	3.60	3.46	3.26	3.56	3.49	3.41	Reliability of Mainframe
3.60	3.17	3.20	3.13	3.18	3.33	3.36	3.45	Reliability of Peripherals
								Maintenance Service:
3.80	3.39	3.40	3.28	3.39	3.04	3.40	3.47	Responsiveness
3.60	3.22	2.80	3.03	3.13	2.98	3.37	3.12	Effectiveness
								Technical Support:
3.20	3.06	2.60	2.64	2.59	2.68	2.93	2.79	Trouble-shooting
2.80	2.82	2.80	2.69	2.59	2.69	2.95	2.71	Education
2.80	2.78	2.40	2.40	2.55	2.52	2.86	2.53	Documentation
								Manufacturer's Software:
4.00	3.19	4.00	3.57	3.14	3.30	3.38	3.18	Operating System
3.60	3.25	3.80	3.34	3.09	3.11	3.15	3.00	Compilers & Assemblers
3.20	2.67	2.67	2.90	2.71	2.88	3.18	2.52	Applications Programs
4.00	2.85	3.80	3.30	3.32	3.22	3.32	3.06	Ease of Programming
3.20	2.80	3.75	3.22	2.95	2.88	3.17	2.94	Ease of Conversion
3.40	3.13	3.40	3.25	3.05	3.14	3.31	3.15	Overall Satisfaction
								Additiona Ratings (4.0-1.0)
3.20	3.10	3.40	3.32	2.91	3.06	3.20	2.97	Ease of Reconfiguration
3.33	2.89	3.25	2.94	2.60	2.69	2.65	2.10	Compatibility of Hardware carried over from other systems
3.20	2.89	3.33	3.12	2.60	2.60	2.84	2.23	Compatibility of Programs/data carried over from other systems
3.20	2.92	3.25	2.98	2.94	2.92	3.27	3.21	Power/energy Efficiency
3.00	2.70	3.33	2.87	2.78	2.68	2.92	2.07	Productivity Aids help keep programming costs low
2.80	2.60	2.50	2.60	2.67	2.63	2.95	2.47	Software/Support promised by vendor
3.80	3.38	3.00	3.04	2.91	3.02	3.17	3.12	Keeping up with & implementing vendor changes to hardware/software (very easy = 4.0; very difficult = 1.0)
2.60	2.83	3.00	2.73	2.74	2.90	3.09	2.68	Delivery/installation of equipment (ahead of schedule = 4.0; very late = 1.0)
3.00	2.76	3.00	2.88	2.78	2.80	3.02	2.88	Delivery of required Software (ahead of schedule = 4.0; very late = 1.0)
								Did the system do what you expected it to do? (%)
100.00	94.44	100.00	90.91	100.00	96.36	83.72	85.29	Yes
0.00	5.56	0.00	5.59	0.00	1.82	6.98	11.76	No
0.00	0.00	0.00	3.50	0.00	1.82	9.30	2.94	Undecided
								Would you recommend system to another user? (%)
100.00	88.89	80.00	86.01	86.36	80.36	86.05	82.35	Yes
0.00	5.56	0.00	4.90	9.09	8.93	4.65	14.71	No
0.00	5.56	20.00	9.09	4.55	10.71	9.30	2.94	Undecided

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Survey Item \ Manufacturer and Model	Digital Equipment PDP-11	Digital Equipment VAX-11	Four-Phase All Models	Harris All Models	Hewlett-Packard 1000	Hewlett-Packard 3000	Honeywell DPS 6	IBM Series 1
No. of User Responses	137	242	31	7	9	157	33	15
Avg. Life of System (months)	53.1	36.9	62.6	34.0	68.4	43.4	33.3	47.8
Acquisition Method (%)								
Purchase	79.85	75.42	3.23	71.43	88.89	78.85	75.76	100.00
Rental or Lease from Mfr.	4.48	4.58	61.29	0.00	11.11	10.90	6.06	0.00
Lease from 3rd Party	15.67	20.00	35.48	28.57	0.00	10.26	18.18	0.00
Principal Applications (%)								
Accounting/Billing	65.69	50.83	67.74	42.86	33.33	72.61	72.73	40.00
Banking—Check Processing/Loans/Savings	2.92	0.83	0.00	0.00	0.00	1.91	3.03	0.00
Construction/Architecture	1.46	4.13	3.23	14.29	0.00	1.91	3.03	0.00
Education—Scheduling/Administration	29.93	30.99	6.45	28.57	0.00	21.66	9.09	6.67
Engineering/Scientific	18.25	44.21	0.00	57.14	66.67	12.74	3.03	6.67
Health Care/Medical	8.03	6.20	41.94	14.29	0.00	4.46	12.12	13.33
Insurance	0.73	4.13	6.45	0.00	0.00	0.64	6.06	0.00
Manufacturing	13.87	14.88	6.45	0.00	0.00	29.94	15.15	20.00
Mathematics/Statistics	16.06	26.86	9.68	85.71	44.44	7.64	6.06	6.67
Order Processing/Inventory Control	39.42	24.38	25.81	14.29	11.11	49.04	42.42	60.00
Payroll/Personnel	42.34	35.95	38.71	28.57	33.33	56.05	51.52	13.33
Petroleum/Fuel Analysis	0.73	1.65	0.00	0.00	0.00	1.91	0.00	6.67
Process Control	8.76	6.20	3.23	0.00	11.11	8.28	3.03	0.00
Purchasing	24.09	17.77	12.90	28.57	0.00	36.94	18.18	20.00
Sales/Distribution	18.25	13.22	3.23	0.00	0.00	31.85	33.33	26.67
Other	21.17	19.01	25.81	0.00	22.22	24.84	30.30	26.67
Source of Applications Programs (%)								
In-house Personnel	80.29	86.36	70.97	71.43	77.78	86.62	84.85	60.00
"Packaged" Programs from Manufacturer	37.96	38.84	38.71	71.43	22.22	32.48	42.42	20.00
Contract Programming	25.55	16.53	25.81	14.29	22.22	31.85	36.36	40.00
Manufacturer's Personnel	2.19	2.07	3.23	0.00	0.00	0.00	6.06	0.00
Independent Suppliers	49.64	59.92	25.81	42.86	33.33	49.68	45.45	20.00
Using Data Base Management System (%)	37.12	41.35	10.00	57.14	44.44	85.16	34.38	40.00
Planning a Data Base Management System in 1984	6.06	14.77	3.33	14.29	11.11	7.10	15.63	6.67
Manufacturer's Package	60.00	46.55	0.00	0.00	100.00	100.00	0.00	0.00
Outside Vendor's Package	40.00	53.45	0.00	100.00	0.00	0.00	100.00	0.00
Using Communications Monitor (%)	4.72	7.83	13.33	14.29	0.00	7.24	10.00	6.67
Planning a Communications Monitor in 1984	7.09	8.26	3.33	14.29	0.00	6.58	10.00	0.00
Manufacturer's Package	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Using Integrated Office Automation Functions (%)	35.34	41.99	55.17	28.57	22.22	35.14	31.25	20.00
Planning Office Automation Functions in 1984	12.03	12.12	6.90	14.29	11.11	22.97	0.00	6.67
Have a Disaster Recovery Plan (%)	51.11	47.70	66.67	57.14	44.44	49.35	61.29	33.33
Plan to in 1984	13.33	18.41	6.67	14.29	0.00	20.78	12.90	13.33

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Digital Equipment PDP-11	Digital Equipment VAX-11	Four-Phase All Models	Harris All Models	Hewlett-Packard 1000	Hewlett-Packard 3000	Honeywell DPS 6	IBM Series 1	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
23.36	39.26	16.13	42.86	22.22	32.48	36.36	46.67	Additional Software from the Manufacturer
38.69	59.09	9.68	42.86	11.11	49.04	27.27	33.33	Proprietary Software from Other Suppliers
42.34	52.07	29.03	57.14	22.22	50.32	45.45	53.33	Expansions to Data Communications Facilities
15.33	19.01	12.90	28.57	11.11	19.11	15.15	20.00	Distributed Processing Capabilities
69.34	71.90	38.71	57.14	33.33	75.16	63.64	46.67	Expansions to Present Hardware
13.14	17.36	3.23	57.14	0.00	15.92	3.03	20.00	Business Graphics
9.49	10.33	6.45	28.57	0.00	9.55	6.06	6.67	Power Conditioning Systems
								System Ratings (4.0-1.0)
3.44	3.53	3.23	3.00	2.89	3.48	3.31	3.00	Ease of Operation
3.55	3.58	3.19	2.71	3.56	3.70	3.03	3.53	Reliability of Mainframe
3.42	3.33	2.87	2.50	3.13	3.61	2.91	3.29	Reliability of Peripherals
								Maintenance Service:
3.44	3.27	3.26	3.00	3.78	3.52	3.28	3.40	Responsiveness
3.37	3.17	3.13	2.71	3.67	3.53	3.13	3.60	Effectiveness
								Technical Support:
3.03	2.91	2.94	2.71	3.11	3.17	2.71	3.00	Trouble-shooting
2.78	2.92	2.77	2.00	2.56	3.00	2.65	2.93	Education
2.91	2.99	2.58	2.00	2.33	2.94	2.65	2.93	Documentation
								Manufacturer's Software:
3.47	3.52	2.96	2.86	3.25	3.46	3.17	2.93	Operating System
3.27	3.45	2.88	2.14	3.25	3.38	3.25	2.92	Compilers & Assemblers
3.09	3.00	2.65	2.50	2.86	3.06	2.65	2.77	Applications Programs
3.20	3.31	3.09	2.43	3.13	3.27	3.03	2.85	Ease of Programming
2.94	3.07	2.45	2.50	2.50	3.15	2.80	3.00	Ease of Conversion
3.31	3.42	3.07	2.71	2.88	3.47	2.97	3.14	Overall Satisfaction
								Additional Ratings (4.0-1.0)
2.99	3.24	2.73	2.57	2.33	3.26	3.03	3.15	Ease of Reconfiguration
3.13	3.11	2.24	2.14	2.56	2.80	2.77	2.69	Compatibility of Hardware carried over from other systems
2.64	2.81	2.41	2.71	2.22	3.04	2.52	2.54	Compatibility of Programs/data carried over from other systems
2.88	2.94	2.96	2.71	2.75	3.23	3.10	3.31	Power/energy Efficiency
2.69	2.92	2.59	2.14	2.56	3.08	2.59	2.85	Productivity Aids help keep programming costs low
2.87	2.90	2.68	2.43	3.22	3.01	2.58	2.46	Software/Support promised by vendor
3.09	3.20	3.14	2.86	2.22	3.31	2.61	3.00	Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
2.83	2.63	2.89	2.86	2.78	2.99	2.79	2.67	Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
2.78	2.76	2.86	2.71	2.78	2.95	2.84	3.00	Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
90.44	93.39	100.00	51.14	100.00	98.73	84.85	73.33	Yes
2.94	2.48	0.00	28.57	0.00	0.00	6.06	13.33	No
6.62	4.13	0.00	14.29	0.00	1.27	9.09	13.33	Undecided
								Would you recommend system to another user? (%)
83.82	94.63	87.10	57.14	66.67	93.59	75.00	53.33	Yes
7.35	1.65	6.45	14.29	11.11	1.92	6.25	33.33	No
8.82	3.72	6.45	28.57	22.22	4.49	18.75	13.33	Undecided

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Survey Item \ Manufacturer and Model	IBM System/23	IBM System/34	IBM System/36	IBM System/38	IBM 8100	MAI/Basic Four All Models	MDS/Qantel All Models	Microdata Reality
No. of User Responses	13	148	67	222	6	12	18	57
Avg. Life of System (months)	36.0	55.2	14.5	35.6	53.0	38.7	48.3	53.1
Acquisition Method (%)								
Purchase	92.31	71.62	62.69	61.54	60.00	83.33	55.56	77.19
Rental or Lease from Mfr.	7.69	18.24	16.42	11.31	40.00	16.67	16.67	7.02
Lease from 3rd Party	0.00	10.14	20.90	27.15	0.00	0.00	27.78	15.79
Principal Applications (%)								
Accounting/Billing	92.31	89.19	86.57	87.84	33.33	83.33	94.44	94.74
Banking—Check Processing/Loans/Savings	0.00	5.41	2.99	3.15	0.00	0.00	0.00	7.02
Construction/Architecture	0.00	3.38	2.99	3.60	16.67	16.67	11.11	5.26
Education—Scheduling/Administration	0.00	8.78	10.45	7.66	16.67	0.00	0.00	1.75
Engineering/Scientific	0.00	4.05	4.48	5.41	33.33	0.00	0.00	1.75
Health Care/Medical	7.69	5.41	2.99	6.76	0.00	0.00	22.22	1.75
Insurance	15.38	3.38	7.46	5.86	0.00	0.00	0.00	10.53
Manufacturing	15.38	22.30	28.36	41.44	50.00	25.00	50.00	24.56
Mathematics/Statistics	0.00	5.41	5.97	7.21	16.67	8.33	0.00	5.26
Order Processing/Inventory Control	15.38	52.70	59.70	65.32	50.00	50.00	83.33	64.91
Payroll/Personnel	61.54	66.22	68.66	72.52	33.33	58.33	77.78	50.88
Petroleum/Fuel Analysis	0.00	1.35	2.99	2.25	0.00	8.33	0.00	0.00
Process Control	7.69	4.73	4.48	4.50	16.67	8.33	0.00	3.51
Purchasing	15.38	27.70	34.33	44.14	33.33	33.33	55.56	43.86
Sales/Distribution	30.77	41.89	44.78	50.90	50.00	41.67	61.11	49.12
Other	38.46	16.89	13.43	14.41	50.00	8.33	16.67	14.04
Source of Applications Programs (%)								
In-house Personnel	38.46	64.86	83.58	95.50	83.33	91.67	27.78	59.65
"Packaged" Programs from Manufacturer	38.46	37.16	34.33	41.44	33.33	50.00	88.89	31.58
Contract Programming	15.38	40.54	35.82	34.23	33.33	33.33	50.00	50.88
Manufacturer's Personnel	0.00	3.38	0.00	0.90	0.00	8.33	22.22	0.00
Independent Suppliers	46.15	39.19	32.84	35.14	16.67	25.00	27.78	42.11
Using Data Base Management System (%)	23.08	5.67	3.13	69.81	50.00	45.45	55.56	75.93
Planning a Data Base Management System in 1984	7.69	9.22	9.38	2.36	16.67	27.27	0.00	0.00
Manufacturer's Package	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Using Communications Monitor (%)	7.69	3.65	0.00	13.00	33.33	0.00	5.56	8.00
Planning a Communications Monitor in 1984	7.69	10.22	14.06	9.50	16.67	18.18	5.56	0.00
Manufacturer's Package	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Using Integrated Office Automation Functions (%)	33.33	25.18	30.65	30.54	16.67	66.67	35.29	20.00
Planning Office Automation Functions in 1984	25.00	17.99	22.58	23.65	16.67	0.00	11.76	22.00
Have a Disaster Recovery Plan (%)	46.15	49.32	53.73	53.88	60.00	25.00	72.22	56.14
Plan to in 1984	7.69	14.38	19.40	21.00	0.00	41.67	11.11	12.28

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

IBM System/23	IBM System/34	IBM System/36	IBM System/38	IBM 8100	MAI/Basic Four All Models	MDS/Qantel All Models	Microdata Reality	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
15.38	14.86	32.84	24.77	33.33	25.00	66.67	19.30	Additional Software from the Manufacturer
38.46	43.24	38.81	42.79	33.33	25.00	33.33	33.33	Proprietary Software from Other Suppliers
15.38	22.97	49.25	50.90	50.00	50.00	38.89	28.07	Expansions to Data Communications Facilities
0.00	2.70	17.91	11.26	16.67	41.67	22.22	7.02	Distributed Processing Capabilities
23.08	56.08	58.21	77.48	50.00	50.00	72.22	57.89	Expansions to Present Hardware
0.00	5.41	11.94	10.81	0.00	25.00	27.78	8.77	Business Graphics
0.00	2.70	4.48	11.26	0.00	8.33	0.00	10.53	Power Conditioning Systems
								System Ratings (4.0-1.0)
3.00	3.48	3.63	3.49	3.33	3.42	3.56	3.63	Ease of Operation
3.31	3.83	3.75	3.75	3.67	3.25	3.72	3.32	Reliability of Mainframe
3.15	3.68	3.67	3.52	3.33	3.00	3.67	3.09	Reliability of Peripherals
								Maintenance Service:
3.08	3.40	3.45	3.55	3.50	3.33	3.61	3.40	Responsiveness
3.15	3.46	3.40	3.55	3.33	3.08	3.61	3.27	Effectiveness
								Technical Support:
2.83	3.06	3.17	3.01	3.17	2.75	3.11	2.89	Trouble-shooting
2.42	2.92	3.23	2.97	3.17	2.42	2.89	2.64	Education
2.75	2.97	3.28	3.00	3.17	2.00	2.71	2.58	Documentation
								Manufacturer's Software:
3.00	3.39	3.54	3.55	3.33	2.92	3.44	3.66	Operating System
3.00	3.40	3.57	3.55	3.40	2.90	3.39	3.35	Compilers & Assemblers
2.70	2.90	3.08	2.83	3.33	2.91	3.17	2.98	Applications Programs
2.92	3.18	3.45	2.67	3.00	3.50	3.31	3.46	Ease of Programming
2.67	2.99	3.52	2.64	3.00	3.00	3.53	3.23	Ease of Conversion
2.67	3.35	3.57	3.47	3.33	3.08	3.33	3.34	Overall Satisfaction
								Additional Ratings (4.0-1.0)
2.67	3.01	3.60	2.92	3.50	3.09	3.76	3.24	Ease of Reconfiguration
2.09	2.78	3.54	2.65	3.75	2.82	2.63	2.84	Compatibility of Hardware carried over from other systems
2.64	2.69	3.53	2.50	3.33	2.50	2.60	2.68	Compatibility of Programs/data carried over from other systems
2.73	3.00	3.48	3.19	3.75	3.00	3.50	2.94	Power/energy Efficiency
2.50	2.83	3.33	3.53	3.25	2.60	3.38	2.92	Productivity Aids help keep programming costs low
2.45	2.87	3.23	3.08	3.50	2.45	2.94	2.64	Software/Support promised by vendor
2.69	3.10	3.39	3.28	2.67	2.75	3.44	3.39	Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
2.92	2.97	3.09	2.93	3.20	2.75	3.00	3.00	Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
2.45	2.93	3.03	2.99	3.20	2.73	2.88	2.78	Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
76.92	93.92	95.52	95.48	100.00	83.33	83.33	89.47	Yes
23.08	1.35	1.49	2.26	0.00	8.33	11.11	3.51	No
0.00	4.73	2.99	2.26	0.00	8.33	5.56	7.02	Undecided
								Would you recommend system to another user? (%)
69.23	95.27	97.01	98.20	100.00	75.00	88.89	87.72	Yes
30.77	1.35	0.00	0.90	0.00	16.67	5.56	7.02	No
0.00	3.38	2.99	0.90	0.00	8.33	5.56	5.26	Undecided

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Survey Item \ Manufacturer and Model	Microdata Sequel	NCR 9000	NCR 9300	Perkin-Elmer 3200	Prime 50 Series	Sperry System 80	Wang VS	Minicomputers (Other Models)
No. of User Responses	21	67	13	21	116	59	135	42
Avg. Life of System (months)	23.3	31.3	10.9	41.0	34.8	35.1	35.8	54.4
Acquisition Method (%)								
Purchase	57.14	47.76	76.92	80.95	56.90	37.29	70.15	76.19
Rental or Lease from Mfr.	0.00	34.33	7.69	4.76	28.45	52.54	14.18	4.76
Lease from 3rd Party	42.86	17.91	15.38	14.29	14.66	10.17	15.67	19.05
Principal Applications (%)								
Accounting/Billing	100.00	94.03	92.31	47.62	58.62	89.83	77.78	71.43
Banking—Check Processing/Loans/Savings	0.00	2.99	15.38	0.00	0.86	0.00	3.70	16.67
Construction/Architecture	9.52	5.97	7.69	4.76	7.76	0.00	2.96	4.76
Education—Scheduling/Administration	4.76	10.45	15.38	14.29	22.41	11.86	8.15	21.43
Engineering/Scientific	4.76	1.49	0.00	23.81	36.21	6.78	6.67	16.67
Health Care/Medical	33.33	19.40	15.38	9.52	2.59	6.78	8.15	16.67
Insurance	14.29	2.99	7.69	0.00	2.59	8.47	5.93	9.52
Manufacturing	38.10	19.40	30.77	14.29	14.66	32.20	20.00	26.19
Mathematics/Statistics	4.76	5.97	15.38	28.57	29.31	1.69	5.93	14.28
Order Processing/Inventory Control	57.14	62.69	69.23	42.86	35.34	69.49	51.85	40.47
Payroll/Personnel	90.48	79.10	76.92	9.52	47.41	72.88	49.63	38.09
Petroleum/Fuel Analysis	0.00	0.00	0.00	0.00	2.59	3.39	4.44	2.38
Process Control	0.00	7.46	15.38	14.29	2.59	1.69	4.44	9.52
Purchasing	71.43	32.84	30.77	33.33	31.03	45.76	30.37	33.33
Sales/Distribution	47.62	29.85	30.77	38.10	22.41	49.15	35.56	40.47
Other	19.05	13.43	7.69	14.29	28.45	15.25	22.96	23.38
Source of Applications Programs (%)								
In-house Personnel	80.95	68.66	53.85	80.95	84.48	93.22	86.67	83.33
"Packaged" Programs from Manufacturer	42.86	56.72	69.23	4.76	30.17	28.81	17.78	38.10
Contract Programming	38.10	40.30	23.08	33.33	19.83	23.73	34.07	21.43
Manufacturer's Personnel	4.76	4.48	0.00	0.00	0.86	8.47	0.74	4.76
Independent Suppliers	61.90	32.84	23.08	23.81	57.76	20.34	43.70	30.95
Using Data Base Management System (%)	85.71	6.45	15.38	66.67	52.63	27.12	6.77	39.02
Planning a Data Base Management System in 1984	0.00	8.06	38.46	0.00	13.16	10.17	13.53	9.76
Manufacturer's Package	100.00	0.00	0.00	100.00	56.52	100.00	0.00	—
Outside Vendor's Package	0.00	0.00	0.00	0.00	32.61	0.00	100.00	—
Using Communications Monitor (%)	0.00	4.92	7.69	14.29	9.09	15.25	8.33	12.19
Planning a Communications Monitor in 1984	9.52	3.28	0.00	4.76	5.45	8.47	9.09	7.32
Manufacturer's Package	0.00	0.00	0.00	0.00	0.00	100.00	0.00	—
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—
Using Integrated Office Automation Functions (%)	33.33	23.33	15.38	10.00	37.27	12.28	61.65	26.83
Planning Office Automation Functions in 1984	38.10	13.33	38.46	20.00	14.55	15.79	13.53	14.63
Have a Disaster Recovery Plan (%)	55.00	62.50	33.33	33.33	48.70	52.63	38.81	48.72
Plan to in 1984	35.00	14.06	25.00	14.29	19.13	17.54	20.90	20.51

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Microdata Sequel	NCR 9000	NCR 9300	Perkin-Elmer 3200	Prime 50 Series	Sperry System 80	Wang VS	Minicomputers (Other Models)	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
47.62	29.85	46.15	38.10	26.72	28.81	31.11	40.47	Additional Software from the Manufacturer
47.62	28.36	38.46	57.14	40.52	32.20	44.44	35.71	Proprietary Software from Other Suppliers
57.14	32.84	7.69	23.81	51.72	45.76	50.37	35.71	Expansions to Data Communications Facilities
23.81	11.94	0.00	9.52	21.55	18.64	20.00	7.14	Distributed Processing Capabilities
76.19	55.22	38.46	61.90	68.10	72.88	75.56	50.00	Expansions to Present Hardware
23.81	7.46	0.00	9.52	24.14	1.69	16.30	14.28	Business Graphics
14.29	4.48	15.38	9.52	18.97	6.78	11.85	7.14	Power Conditioning Systems
								System Ratings (4.0-1.0)
3.71	3.40	3.69	2.76	3.41	3.34	3.74	3.51	Ease of Operation
3.38	3.55	3.85	3.52	3.60	3.39	3.53	3.64	Reliability of Mainframe
3.29	3.50	3.67	3.38	3.37	3.19	3.26	3.56	Reliability of Peripherals
								Maintenance Service:
3.43	3.55	3.62	3.10	3.39	3.42	3.11	3.37	Responsiveness
3.19	3.46	3.85	2.95	3.17	3.32	3.06	3.22	Effectiveness
								Technical Support:
3.00	2.89	3.23	2.67	2.70	2.80	2.63	3.26	Trouble-shooting
2.62	2.89	3.15	2.37	2.73	2.45	2.64	3.13	Education
2.86	2.65	3.00	2.43	2.60	2.44	2.55	2.85	Documentation
								Manufacturer's Software:
3.75	3.19	3.54	2.81	3.33	3.19	3.26	3.45	Operating System
3.60	3.18	3.50	2.86	3.00	3.22	3.37	3.31	Compilers & Assemblers
3.38	2.73	3.25	2.45	2.78	2.70	2.98	2.90	Applications Programs
3.80	3.37	3.31	2.85	3.25	3.17	3.62	3.24	Ease of Programming
3.45	3.14	3.31	2.94	3.19	2.78	3.44	2.89	Ease of Conversion
3.65	3.24	3.54	2.90	3.29	2.98	3.34	3.39	Overall Satisfaction
								Additional Ratings (4.0-1.0)
3.43	3.17	3.77	2.95	3.27	2.92	3.54	3.03	Ease of Reconfiguration
3.20	2.89	3.58	2.44	3.30	2.26	2.21	2.90	Compatibility of Hardware carried over from other systems
2.95	2.84	3.54	2.95	3.09	2.95	2.97	2.69	Compatibility of Programs/data carried over from other systems
3.05	3.08	3.85	2.84	3.12	3.15	3.07	3.16	Power/energy Efficiency
3.22	2.82	3.23	2.26	2.97	2.83	3.38	2.68	Productivity Aids help keep programming costs low
3.05	2.66	3.23	2.26	2.61	2.60	2.61	2.95	Software/Support promised by vendor
3.24	3.11	3.31	2.57	3.08	2.86	3.02	3.10	Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
3.00	2.92	2.85	2.90	3.10	2.81	2.57	3.05	Delivery/Installation of equipment (ahead of schedule=4.0, very late=1.0)
3.05	2.77	2.75	2.80	3.02	2.79	2.60	2.83	Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
95.24	91.04	92.31	76.19	93.04	81.36	92.59	92.86	Yes
0.00	4.48	0.00	14.29	2.61	15.25	2.96	4.76	No
4.76	4.48	7.69	9.52	4.35	3.39	4.44	2.38	Undecided
								Would you recommend system to another user? (%)
100.00	83.58	100.00	61.90	91.38	76.27	91.85	84.61	Yes
0.00	5.97	0.00	23.81	3.45	10.17	1.48	5.13	No
0.00	10.45	0.00	14.29	5.17	13.56	6.67	10.26	Undecided

User Ratings of Minicomputer Systems

TABLE 2. MINICOMPUTER VENDOR SUMMARIES

Survey Item \ Manufacturer and Model	Burroughs	Data General	Datapoint	Digital Equipment	Four-Phase	Harris	Hewlett-Packard	Honeywell
No. of User Responses	171	122	34	379	31	7	166	33
Avg. Life of System (months)	39.8	43.2	30.3	42.7	62.6	34.0	44.6	33.3
Acquisition Method (%)								
Purchase	54.12	83.61	64.71	77.01	3.23	71.43	79.39	75.76
Rental or Lease from Mfr.	36.47	1.64	26.47	4.55	61.29	0.00	10.91	6.06
Lease from 3rd Party	9.41	14.75	8.82	18.45	35.48	28.57	9.70	18.18
Principal Applications (%)								
Accounting/Billing	77.78	68.85	76.47	56.20	67.74	42.86	70.48	72.73
Banking—Check Processing/Loans/Savings	14.04	3.28	0.00	1.58	0.00	0.00	1.81	3.03
Construction/Architecture	1.17	4.10	0.00	3.17	3.23	14.29	1.81	3.03
Education—Scheduling/Administration	15.20	13.93	2.94	30.61	6.45	28.57	20.48	9.09
Engineering/Scientific	3.51	12.30	2.94	34.83	0.00	57.14	15.66	3.03
Health Care/Medical	8.77	14.75	5.88	6.86	41.94	14.29	4.22	12.12
Insurance	4.68	7.38	5.88	2.90	6.45	0.00	0.60	6.06
Manufacturing	19.30	13.11	11.76	14.51	6.45	0.00	28.31	15.15
Mathematics/Statistics	4.68	11.48	5.88	22.96	9.68	85.71	9.64	6.06
Order Processing/Inventory Control	46.20	43.44	41.18	29.82	25.81	14.29	46.99	42.42
Payroll/Personnel	69.59	44.26	47.06	38.26	38.71	28.57	54.82	51.52
Petroleum/Fuel Analysis	1.17	2.46	0.00	1.32	0.00	0.00	1.81	0.00
Process Control	2.34	2.46	8.82	7.12	3.23	0.00	8.43	3.03
Purchasing	38.60	22.95	17.65	20.05	12.90	28.57	34.94	18.18
Sales/Distribution	28.07	20.49	44.12	15.04	3.23	0.00	30.12	33.33
Other	16.96	27.05	17.65	19.79	25.81	0.00	24.70	30.30
Source of Applications Programs (%)								
In-house Personnel	73.68	75.41	94.12	84.17	70.97	71.43	86.14	84.85
"Packaged" Programs from Manufacturer	33.33	21.31	5.88	38.52	38.71	71.43	31.93	42.42
Contract Programming	25.73	31.15	32.35	19.79	25.81	14.29	31.33	36.36
Manufacturer's Personnel	4.68	1.64	0.00	2.11	3.23	0.00	0.00	6.06
Independent Suppliers	38.01	48.36	17.65	56.20	25.81	42.86	48.80	45.45
Using Data Base Management System (%)	46.78	34.48	8.82	39.84	10.00	57.14	82.93	34.38
Planning a Data Base Management System in 1984	18.13	12.93	11.76	11.65	3.33	14.29	7.32	15.63
Manufacturer's Package	100.00	100.00	0.00	49.30	0.00	0.00	100.00	0.00
Outside Vendor's Package	0.00	0.00	0.00	50.70	0.00	100.00	0.00	100.00
Using Communications Monitor (%)	20.73	9.91	9.09	6.72	13.33	14.29	6.88	10.00
Planning a Communications Monitor in 1984	3.05	7.21	0.00	7.84	3.33	14.29	6.25	10.00
Manufacturer's Package	100.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Using Integrated Office Automation Functions (%)	14.91	36.61	65.63	39.56	55.17	28.57	34.39	31.25
Planning Office Automation Functions in 1984	17.39	16.07	9.38	12.09	6.90	14.29	22.29	0.00
Have a Disaster Recovery Plan (%)	52.98	50.83	60.61	48.93	66.67	57.14	49.08	61.29
Plan to in 1984	13.10	19.17	6.06	16.58	6.67	14.29	19.63	12.90

User Ratings of Minicomputer Systems

TABLE 2. MINICOMPUTER VENDOR SUMMARIES

Burroughs	Data General	Datapoint	Digital Equipment	Four-Phase	Harris	Hewlett-Packard	Honeywell	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
27.49	27.05	50.00	33.51	16.13	42.86	31.93	36.36	Additional Software from the Manufacturer
28.65	47.54	23.53	51.72	9.68	42.86	46.99	27.27	Proprietary Software from Other Suppliers
47.95	35.25	52.94	48.55	29.03	57.14	48.80	45.45	Expansions to Data Communications Facilities
20.47	13.11	17.65	17.68	12.90	28.57	18.67	15.15	Distributed Processing Capabilities
54.39	58.20	70.59	70.98	38.71	57.14	72.89	63.64	Expansions to Present Hardware
9.36	9.02	8.82	15.83	3.23	57.14	15.06	3.03	Business Graphics
7.02	19.67	5.88	10.03	6.45	28.57	9.04	6.06	Power Conditioning Systems
								System Ratings (4.0-1.0)
3.52	3.36	3.12	3.50	3.23	3.00	3.45	3.31	Ease of Operation
3.48	3.48	3.41	3.57	3.19	2.71	3.69	3.03	Reliability of Mainframe
3.15	3.31	3.45	3.36	2.87	2.50	3.59	2.91	Reliability of Peripherals
								Maintenance Service:
3.31	3.23	3.47	3.33	3.26	3.00	3.54	3.28	Responsiveness
3.06	3.15	3.12	3.24	3.13	2.71	3.54	3.13	Effectiveness
								Technical Support:
2.70	2.75	2.79	2.95	2.94	2.71	3.17	2.71	Trouble-shooting
2.71	2.77	2.71	2.87	2.77	2.00	2.98	2.65	Education
2.45	2.65	2.53	2.96	2.58	2.00	2.90	2.65	Documentation
								Manufacturer's Software:
3.56	3.30	3.18	3.50	2.96	2.86	3.45	3.17	Operating System
3.36	3.12	3.00	3.39	2.88	2.14	3.37	3.25	Compilers & Assemblers
2.88	2.96	2.52	3.03	2.65	2.50	3.05	2.65	Applications Programs
3.30	3.28	3.06	3.27	3.09	2.43	3.26	3.03	Ease of Programming
3.21	3.01	2.94	3.02	2.45	2.50	3.11	2.80	Ease of Conversion
3.25	3.19	3.15	3.38	3.07	2.71	3.44	2.97	Overall Satisfaction
								Additional Ratings (4.0-1.0)
3.31	3.08	2.97	3.15	2.73	2.57	3.21	3.03	Ease of Reconfiguration
2.95	2.66	2.10	3.12	2.24	2.14	2.78	2.77	Compatibility of Hardware carried over from other systems
3.11	2.69	2.23	2.75	2.41	2.71	2.99	2.52	Compatibility of Programs/data carried over from other systems
2.99	3.06	3.21	2.92	2.96	2.71	3.21	3.10	Power/energy Efficiency
2.87	2.79	2.07	2.84	2.59	2.14	3.05	2.59	Productivity Aids help keep programming costs low
2.61	2.75	2.47	2.89	2.68	2.43	3.02	2.58	Software/Support promised by vendor
3.09	3.05	3.12	3.16	3.14	2.86	3.25	2.61	Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
2.75	2.94	2.68	2.70	2.89	2.86	2.98	2.79	Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
2.87	2.88	2.88	2.77	2.86	2.71	2.94	2.84	Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
91.81	92.56	85.29	92.33	100.00	57.14	98.80	84.85	Yes
5.26	3.31	11.76	2.65	0.00	28.57	0.00	6.06	No
2.92	4.13	2.94	5.03	0.00	14.29	1.20	9.09	Undecided
								Would you recommend system to another user? (%)
86.55	83.47	82.35	90.74	87.10	57.14	92.12	75.00	Yes
4.68	7.44	14.71	3.70	6.45	14.29	2.42	6.25	No
8.77	9.09	2.94	5.56	6.45	28.57	5.45	18.75	Undecided

User Ratings of Minicomputer Systems

TABLE 2. MINICOMPUTER VENDOR SUMMARIES

Survey Item / Manufacturer and Model	IBM	MAI/Basic Four	MDS/Qantel	Microdata	NCR	Perkin-Elmer	Prime	Sperry
No. of User Responses	471	12	18	78	80	21	116	59
Avg. Life of System (months)	39.3	38.7	48.3	44.7	27.9	41.0	34.8	35.1
Acquisition Method (%)								
Purchase	66.95	83.33	55.56	71.79	52.50	80.95	56.90	37.29
Rental or Lease from Mfr.	14.07	16.67	16.67	5.13	30.00	4.76	28.45	52.54
Lease from 3rd Party	18.98	0.00	27.78	23.08	17.50	14.29	14.66	10.17
Principal Applications (%)								
Accounting/Billing	85.99	83.33	94.44	96.15	93.75	47.62	58.62	89.83
Banking—Check Processing/Loans/Savings	3.61	0.00	0.00	5.13	5.00	0.00	0.86	0.00
Construction/Architecture	3.40	16.67	11.11	6.41	6.25	4.76	7.76	0.00
Education—Scheduling/Administration	8.28	0.00	0.00	2.56	11.25	14.29	22.41	11.86
Engineering/Scientific	5.10	0.00	0.00	2.56	1.25	23.81	36.21	6.78
Health Care/Medical	5.94	0.00	22.22	10.26	18.75	9.52	2.59	6.78
Insurance	5.31	0.00	0.00	11.54	3.75	0.00	2.59	8.47
Manufacturing	32.27	25.00	50.00	28.21	21.25	14.29	14.66	32.20
Mathematics/Statistics	6.37	8.33	0.00	5.13	7.50	28.57	29.31	1.69
Order Processing/Inventory Control	58.81	50.00	83.33	62.82	63.75	42.86	35.34	69.49
Payroll/Personnel	67.30	58.33	77.78	61.54	78.75	9.52	47.41	72.88
Petroleum/Fuel Analysis	2.12	8.33	0.00	0.00	0.00	0.00	2.59	3.39
Process Control	4.67	8.33	0.00	2.56	8.75	14.29	2.59	1.69
Purchasing	35.88	33.33	55.56	51.28	32.50	33.33	31.03	45.76
Sales/Distribution	45.86	41.67	61.11	48.72	30.00	38.10	22.41	49.15
Other	16.56	8.33	16.67	15.38	12.50	14.29	28.45	15.25
Source of Applications Programs (%)								
In-house Personnel	81.32	91.67	27.78	65.38	66.25	80.95	84.48	93.22
"Packaged" Programs from Manufacturer	38.22	50.00	88.89	34.62	58.75	4.76	30.17	28.81
Contract Programming	36.09	33.33	50.00	47.44	37.50	33.33	19.83	23.73
Manufacturer's Personnel	1.49	8.33	22.22	1.28	3.75	0.00	0.86	8.47
Independent Suppliers	35.67	25.00	27.78	47.44	31.25	23.81	57.76	20.34
Using Data Base Management System (%)	37.69	45.45	55.56	78.67	8.00	66.67	52.63	27.12
Planning a Data Base Management System in 1984	5.99	27.27	0.00	0.00	13.33	0.00	13.16	10.17
Manufacturer's Package	100.00	0.00	0.00	100.00	0.00	100.00	56.52	100.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	43.48	0.00
Using Communications Monitor (%)	8.05	0.00	5.56	5.63	5.41	14.29	9.09	15.25
Planning a Communications Monitor in 1984	10.11	18.18	5.56	2.82	2.70	4.76	5.45	8.47
Manufacturer's Package	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Using Integrated Office Automation Functions (%)	28.38	66.67	35.29	23.94	21.92	10.00	37.27	12.28
Planning Office Automation Functions in 1984	21.05	0.00	11.76	26.76	17.81	20.00	14.55	15.79
Have a Disaster Recovery Plan (%)	51.61	25.00	72.22	55.84	57.89	33.33	48.70	52.63
Plan to in 1984	17.85	41.67	11.11	18.18	15.79	14.29	19.13	17.54

User Ratings of Minicomputer Systems

TABLE 2. MINICOMPUTER VENDOR SUMMARIES

IBM	MAI/Basic Four	MDS/Qantel	Microdata	NCR	Perkin-Elmer	Prime	Sperry	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
23.35	25.00	66.67	26.92	32.50	38.10	26.72	28.81	Additional Software from the Manufacturer
41.83	25.00	33.33	37.18	30.00	57.14	40.52	32.20	Proprietary Software from Other Suppliers
40.98	50.00	38.89	35.90	28.75	23.81	51.72	45.76	Expansions to Data Communications Facilities
9.55	41.67	22.22	11.54	10.00	9.52	21.55	18.64	Distributed Processing Capabilities
65.18	50.00	72.22	62.82	52.50	61.90	68.10	72.88	Expansions to Present Hardware
9.13	25.00	27.78	12.82	6.25	9.52	24.14	1.69	Business Graphics
7.01	8.33	0.00	11.54	6.25	9.52	18.97	6.78	Power Conditioning Systems
								System Ratings (4.0-1.0)
3.48	3.42	3.56	3.65	3.45	2.76	3.41	3.34	Ease of Operation
3.76	3.25	3.72	3.33	3.59	3.52	3.60	3.39	Reliability of Mainframe
3.57	3.00	3.67	3.14	3.53	3.38	3.37	3.19	Reliability of Peripherals
								Maintenance Service:
3.47	3.33	3.61	3.41	3.56	3.10	3.39	3.42	Responsiveness
3.49	3.08	3.61	3.25	3.52	2.95	3.17	3.32	Effectiveness
								Technical Support:
3.04	2.75	3.11	2.92	2.95	2.67	2.70	2.80	Trouble-shooting
2.98	2.42	2.89	2.64	2.94	2.37	2.73	2.45	Education
3.02	2.00	2.71	2.65	2.71	2.43	2.60	2.44	Documentation
								Manufacturer's Software:
3.46	2.92	3.44	3.68	3.25	2.81	3.33	3.19	Operating System
3.47	2.90	3.39	3.42	3.23	2.86	3.00	3.22	Compilers & Assemblers
2.89	2.91	3.17	3.09	2.82	2.45	2.78	2.70	Applications Programs
3.44	3.50	3.31	3.56	3.36	2.85	3.25	3.17	Ease of Programming
2.89	3.00	3.53	3.29	3.16	2.94	3.19	2.78	Ease of Conversion
3.42	3.08	3.33	3.42	3.29	2.90	3.29	2.98	Overall Satisfaction
								Additional Ratings (4.0-1.0)
3.05	3.09	3.76	3.30	3.27	2.95	3.27	2.92	Ease of Reconfiguration
2.82	2.82	2.63	2.94	3.01	2.44	3.30	2.26	Compatibility of Hardware carried over from other systems
2.72	2.50	2.60	2.76	2.96	2.95	3.09	2.95	Compatibility of Programs/data carried over from other systems
3.17	3.00	3.50	2.97	3.21	2.84	3.12	3.15	Power/energy Efficiency
3.25	2.60	3.38	3.00	2.90	2.26	2.97	2.83	Productivity Aids help keep programming costs low
3.01	2.45	2.94	2.75	2.76	2.26	2.61	2.60	Software/Support promised by vendor
3.20	2.75	3.44	3.35	3.14	2.57	3.08	2.86	Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
2.96	2.75	3.00	3.00	2.91	2.90	3.10	2.81	Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
2.97	2.73	2.88	2.86	2.77	2.80	3.02	2.79	Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
93.83	83.33	83.33	91.03	91.25	76.19	93.04	81.36	Yes
2.77	8.33	11.11	2.56	3.75	14.29	2.61	15.25	No
3.40	8.33	5.56	6.41	5.00	9.52	4.35	3.39	Undecided
								Would you recommend system to another user? (%)
94.90	75.00	88.89	91.03	86.25	61.90	91.38	76.27	Yes
2.76	16.67	5.56	5.13	5.00	23.81	3.45	10.17	No
2.34	8.33	5.56	3.85	8.75	14.29	5.17	13.56	Undecided

User Ratings of Minicomputer Systems

TABLE 2. MINICOMPUTER VENDOR SUMMARIES

Manufacturer and Model / Survey Item	Wang	Other Minicomputers						
No. of User Responses	135	42						
Avg. Life of System (months)	35.8	54.3						
Acquisition Method (%)								
Purchase	70.15	76.19						
Rental or Lease from Mfr.	14.18	4.76						
Lease from 3rd Party	15.67	19.05						
Principal Applications (%)								
Accounting/Billing	77.78	71.43						
Banking—Check Processing/Loans/Savings	3.70	16.67						
Construction/Architecture	2.96	4.76						
Education—Scheduling/Administration	8.15	21.43						
Engineering/Scientific	6.67	16.67						
Health Care/Medical	8.15	16.67						
Insurance	5.93	9.52						
Manufacturing	20.00	26.19						
Mathematics/Statistics	5.93	14.28						
Order Processing/Inventory Control	51.85	40.47						
Payroll/Personnel	49.63	38.09						
Petroleum/Fuel Analysis	4.44	2.38						
Process Control	4.44	9.52						
Purchasing	30.37	33.33						
Sales/Distribution	35.56	40.47						
Other	22.96	23.81						
Source of Applications Programs (%)								
In-house Personnel	86.67	83.33						
"Packaged" Programs from Manufacturer	17.78	38.10						
Contract Programming	34.07	21.43						
Manufacturer's Personnel	0.74	4.76						
Independent Suppliers	43.70	30.95						
Using Data Base Management System (%)	6.77	39.02						
Planning a Data Base Management System in 1984	13.53	9.76						
Manufacturer's Package	0.00	—						
Outside Vendor's Package	100.00	—						
Using Communications Monitor (%)	8.33	12.20						
Planning a Communications Monitor in 1984	9.09	7.23						
Manufacturer's Package	0.00	—						
Outside Vendor's Package	0.00	—						
Using Integrated Office Automation Functions (%)	61.65	26.83						
Planning Office Automation Functions in 1984	13.53	14.63						
Have a Disaster Recovery Plan (%)	38.81	48.72						
Plan to in 1984	20.90	20.51						

User Ratings of Minicomputer Systems

TABLE 2. MINICOMPUTER VENDOR SUMMARIES

Wang	Other Minicomputers							Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
31.11	40.47							Additional Software from the Manufacturer
44.44	35.71							Proprietary Software from Other Suppliers
50.37	35.71							Expansions to Data Communications Facilities
20.00	7.14							Distributed Processing Capabilities
75.56	50.00							Expansions to Present Hardware
16.30	14.28							Business Graphics
11.85	7.14							Power Conditioning Systems
								System Ratings (4.0-1.0)
3.74	3.51							Ease of Operation
3.53	3.64							Reliability of Mainframe
3.26	3.56							Reliability of Peripherals
								Maintenance Service:
3.11	3.37							Responsiveness
3.06	3.20							Effectiveness
								Technical Support:
2.63	3.26							Trouble-shooting
2.64	3.13							Education
2.55	2.85							Documentation
								Manufacturer's Software:
3.26	3.45							Operating System
3.37	3.32							Compilers & Assemblers
2.98	2.90							Applications Programs
3.62	3.24							Ease of Programming
3.44	2.89							Ease of Conversion
3.34	3.39							Overall Satisfaction
								Additional Ratings (4.0-1.0)
3.54	3.03							Ease of Reconfiguration
2.21	2.90							Compatibility of Hardware carried over from other systems
2.97	2.70							Compatibility of Programs/data carried over from other systems
3.07	3.17							Power/energy Efficiency
3.38	2.68							Productivity Aids help keep programming costs low
2.61	2.95							Software/Support promised by vendor
3.02	3.10							Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
2.57	3.05							Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
2.60	2.83							Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
92.59	92.86							Yes
2.96	4.76							No
4.44	2.38							Undecided
								Would you recommend system to another user? (%)
91.85	84.61							Yes
1.48	5.13							No
6.67	10.26							Undecided

User Ratings of Minicomputer Systems

This report presents the results of Datapro's 1984 survey of computer users. User experiences with over 1900 minicomputer systems have been summarized and are presented in the accompanying tables. These user ratings evaluate the performance, reliability, and vendor support for the most popular minicomputers sold today. The information provided by the actual users of these systems can aid a prospective user in the evaluation of a minicomputer acquisition.

Datapro is pleased to present, in conjunction with *Computerworld*, the 1984 edition of the annual Computer Users Survey. This year's survey is based on responses to questionnaires mailed to a cross-section of computer sites listed with International Data Corporation (IDC). This report summarizes the results received from minicomputer users. For the results of the mainframe users polled, please reference *DATAPRO 70*. The users were asked to rate their systems in 25 subjective categories and respond to a variety of questions covering such areas as system configuration, languages, data base management, and whether they would recommend the system to another user.

Our purpose in using IDC's list of known computer sites was twofold: to select only currently marketed system models, and to improve the results for those models. The number of responses received for models which are no longer in production, like the IBM System/370 or IBM System/3, was dramatically reduced. In addition, the number of responses received for the systems we selected increased over last year's responses in over 50 percent of the cases. Some of those increases were rather dramatic; we received over 200 percent more responses for the Wang VS and 134 percent more for the DEC VAX systems. By using IDC's list, we received responses for systems recently introduced, also. Nine users of the IBM 4361/4381, delivered for the first time early in 1984, responded to our questionnaire, and over 60 responses came in for the IBM System/36, delivered for the first time in the late summer of 1983. The NCR 9300 and Sperry 1100/70 were also included in the survey for the first time.

We would like to stress that individual profiles or ratings should never be the major consideration in making an acquisition decision. The reader can use the material in this report to help formulate questions about a computer system as the evaluation process proceeds. The information within this report is very informative if used with discretion and with the understanding that there are many factors involved in selecting the right computer system to meet your particular needs.

SURVEY METHODOLOGY

The 1984 survey has been based on results received from 15,000 questionnaires mailed to known computer sites listed with IDC. The total number of questionnaires was divided into two groups: 9000 surveys were mailed to minicomputer users and 6000 to mainframe users. In addition, the sites were chosen based on the computer system they had installed. Datapro supplied IDC with a list of specific system models to be included in the mailing and the model was listed directly on the mailing label. In an effort to improve the response rate and thereby increase the statistical validity, the users were contacted twice; a first request was followed two weeks later by a second request.

Each questionnaire allowed the user to rate one computer system and specifically requested that the rating apply to the system listed on the label. The recipient was encouraged to reproduce the form if he/she wished to rate additional systems. The IDC labels were used as initial validation vehicles and for identification and elimination of invalid and duplicate returns. All returns were analyzed by senior Datapro analysts and some returns were judged invalid for one or more of the following reasons: more than one system model was rated on a single form; the response was a duplicate; the form was received after the deadline; the ratings section of the questionnaire was not completed; the systems rated were not mainframe or minicomputer systems; or the response revealed a vested interest on the part of the respondent. In addition, system models receiving less than five responses were not included in the final analysis, although the responses were considered to be valid.

Of the 15,000 questionnaires mailed, 3404 responses were received from 3261 respondents, a return of 22 percent on the total mailing. Of the total responses, 352 were judged to be invalid, giving us 3052 valid responses from 2909 users. Of these valid responses, 1079 rated mainframe computer systems, for a return of 18 percent on the 6000 surveys mailed to mainframe users, and 1973 rated minicomputer systems, for a return of 22 percent on the 9000 surveys mailed to minicomuter users.

Datapro batched the valid returns by manufacturer and model and sent the returns to Mathematica Policy Research, Inc. for tabulation of the results. The summary information was prepared in the form of either averages, percentages, or weighted averages. Weighted averages were computed in a manner similar to most college grading systems: "Excellent" is weighted as 4, "Good" as 3, "Fair" as 2, and "Poor" as 1. The tallied numbers for each value are then multiplied by the corresponding weight, and the average is taken by dividing the sum of the products by the total number of responses for that category.

THE 1984 QUESTIONNAIRE

Users were asked to answer 27 multiple-part questions. Each user was asked to identify the manufacturer and model of their system, as well as the month and year of acquisition, and method of acquisition. Users were requested to identify the type of industry their company was in, ▷

User Ratings of Minicomputer Systems

Chart 1. Usage of Local and Remote Workstations/Terminals

No. of Workstations/ Terminals per System / Manufacturer & Model	Local						Remote					
	None	1-5	6-15	16-30	31-60	Over 60	None	1-5	6-15	16-30	31-60	Over 60
Burroughs:												
B 1800	0	1	3	0	1	0	1	2	1	1	0	0
B 90	1	15	2	0	0	0	15	1	0	0	0	0
B 900	0	1	2	1	0	1	1	2	2	0	0	0
B 1900	1	30	53	43	14	2	47	34	29	16	8	5
Data General:												
CS Series	0	10	8	5	0	0	17	3	1	2	0	0
Eclipse	1	16	16	16	2	4	27	20	8	0	1	0
Eclipse/MV	0	0	13	14	11	5	8	13	7	9	5	1
Datapoint, all models	1	5	17	9	2	0	18	8	3	2	1	0
Digital Equipment:												
PDP-11	0	13	50	36	26	12	31	58	25	12	10	0
VAX-11	0	11	55	65	73	37	44	79	48	24	16	20
Four-Phase, all models	0	3	15	7	5	1	24	4	1	0	1	0
Harris, all models	0	1	3	2	0	1	1	1	0	0	2	3
Hewlett-Packard:												
1000	0	6	2	1	0	0	5	3	1	0	0	0
3000	0	8	47	52	40	8	41	58	29	14	11	2
Honeywell DPS6	0	6	13	9	4	1	16	13	3	0	0	1
IBM:												
Series 1	0	7	8	0	0	0	6	8	0	0	0	0
System/23	0	13	0	0	0	0	13	0	0	0	0	0
System/34	0	58	80	9	0	0	99	39	4	0	0	0
System/36	0	16	38	11	2	0	38	18	8	2	0	0
System/38	0	7	75	88	44	8	80	62	45	21	7	5
8100	0	0	3	0	2	0	5	0	0	1	0	0
MAI/Basic Four, all models	0	2	3	5	2	0	2	7	2	1	0	0
MDS/Qantel, all models	0	4	9	5	0	0	10	6	0	0	0	0
Microdata:												
Reality	0	9	36	7	4	0	26	23	4	2	0	0
Sequel	0	0	0	8	12	1	5	7	2	5	1	0
NCR:												
9000	0	23	29	9	5	1	36	18	6	3	1	0
9300	0	5	8	0	0	0	5	6	2	0	0	0
Perkin-Elmer 3200	0	4	11	2	3	1	6	6	5	2	1	1
Prime 50 Series	0	4	26	34	37	15	27	31	19	20	7	8
Sperry System 80	1	9	37	10	1	1	33	11	9	1	0	1
Wang VS	0	21	56	32	20	4	60	57	6	5	3	0
Other Minicomputers	1	16	15	3	5	2	15	14	6	1	0	3
All Minicomputers	6	324	733	483	315	105	762	612	276	144	75	50

principal applications, and the source of those applications programs. We also asked the users for information about their hardware and software configurations, and about acquisitions or implementations planned for 1984.

The remaining questions asked the users to rate various aspects of their computer systems. The categories rated included: ease of operation, reliability of system, reliability of peripherals, maintenance service (responsiveness and effectiveness), technical support (troubleshooting, education, and documentation), manufacturer's software (operating system, compilers and assemblers, and application programs), ease of programming, ease of conversion, and overall satisfaction. Additional ratings added this year included: ease of reconfiguration, compatibility of terminals, peripherals, and software carried over from other systems, power/energy efficiency, productivity aids, software/support promised by the vendor, delivery of hardware and required software, noise level of equipment, and how easy or difficult was it to keep up with and implement vendor changes to hardware/software. In addition, if utilizing a data base management system or communications monitor, the user was asked to identify the vendor and package, and to rate the technical support and their overall satisfaction with the package.

Finally, the user was asked whether the computer system did what it was expected to do, and whether they would recommend their computer system to another user.

SURVEY RESULTS

Table 1 summarizes the results of the 1975 responses received from minicomputer users. Thirty-one system

User Ratings of Minicomputer Systems

Manufacturer	Number Installed
Apple	3966
IBM	3177
DEC	1440
Radio-Shack	743
Hewlett-Packard	716
Data General	576
Burroughs	371
Texas Instruments	280
NCR	104
Honeywell	36

Chart 2. Number of microcomputers installed at respondent's sites.

models from 17 minicomputer manufacturers are represented in the table. Table 2, "Minicomputer Vendor Summaries," contains the same results as Table 1, summarized by manufacturer.

Hardware Configurations

Forty percent of the users reported memory capacities of between 512KB and one megabyte; 22 percent reported from one to two megabytes; 21 percent reported from two to four megabytes of memory and the remaining 17 percent reported memory capacities of over four megabytes. The majority of the users (43 percent) have between 100 and 600 megabytes of disk storage and another 37 percent reported over 600 megabytes of total disk storage.

We also asked the users how many local workstations/terminals and how many remote workstations/terminals they were using. Chart 1 shows the usage of local and remote terminals by manufacturer and model. Approximately 37 percent were using between 6 and 15 local terminals, another 25 percent had between 16 and 30 local terminals, and 21 percent were using over 31 local terminals. The majority of users (40 percent) had no remote terminals. Thirty-two percent were using between 1 and 5 remote terminals, another 14 percent had between 6 and 15 remote terminals, and 14 percent were using over 16 remote terminals.

Asked for the first time this year was a question on the number of microcomputers installed at the user's site. We wanted to see just how widespread the use of micros is in the business world and which micros are the most popular. While Apple is still leading, it seems certain that IBM will catch up or probably surpass Apple as the leading micro in next year's survey.

There are so many Apple and IBM microcomputers installed that we thought it would be interesting to see if they were being used by certain sites. Chart 3 shows the percentage of the total Apple and IBM micros installed at sites with specific vendor's systems. DEC users have the largest percentage of the Apples installed and specifically, 35 percent of the Apples are installed by VAX users. Notice, also,

Mini Installed	APPLE	IBM
Burroughs	18%	5%
DEC	47%	30%
Data General	4%	3%
Hewlett-Packard	8%	9%
IBM	6%	26%
Microdata	—	8%
NCR	3%	—
Prime	9%	8%
Wang	—	4%

Chart 3. Pecentage of total Apple or IBM microcomputers installed by users with a particular vendor's mini.

Chart 4. Computer Usage by Manufacturer and Industry Type

Manufacturer \ Type of Industry	Banking/Finance/ Securities	Chemical/ Petroleum	Construction	Education	Engineering/ Scientific	Government	Health Care/ Medical	Insurance	Legal	Manufacturing	Media	Public Accounting/ Consulting	Retail/Wholesale	Service Bureau	Transportation	Utilities (Public)	Other
Burroughs (171)	12.28	2.34	1.75	12.28	0.58	11.11	5.26	2.92	0.00	23.39	0.58	2.34	11.70	4.09	1.75	1.17	6.43
Data General (120)	5.00	1.67	1.67	3.33	5.00	6.67	13.33	2.50	3.33	15.83	0.83	2.50	12.50	10.00	1.67	0.00	14.17
Datapoint (34)	14.71	5.88	0.00	2.94	2.94	2.94	0.00	2.94	0.00	14.71	2.94	0.00	0.00	20.59	11.76	0.00	17.65
Digital Equipment (378)	2.12	2.12	0.79	28.31	12.17	4.76	5.29	0.53	0.79	15.34	1.59	1.85	5.29	4.50	0.79	1.59	12.17
Four-Phase (31)	6.45	0.00	0.00	3.23	0.00	16.13	48.39	3.23	3.23	9.68	0.00	0.00	0.00	0.00	0.00	0.00	9.68
Harris (7)	0.00	0.00	0.00	57.14	0.00	14.29	0.00	0.00	0.00	14.29	0.00	0.00	0.00	0.00	0.00	14.29	0.00
Hewlett-Packard (165)	1.82	4.24	0.61	13.33	4.24	9.70	2.42	0.61	0.61	27.88	1.82	1.21	7.27	5.45	2.42	0.61	15.76
Honeywell (33)	12.12	0.00	3.03	0.00	0.00	12.12	9.09	3.03	0.00	27.27	0.00	0.00	21.21	0.00	0.00	0.00	12.12
IBM (471)	4.67	2.55	2.55	4.25	0.64	5.52	3.82	2.76	0.85	33.76	1.49	2.97	16.99	2.97	2.12	1.27	10.83
MAI/Basic Four (12)	8.33	0.00	16.67	0.00	0.00	0.00	0.00	0.00	0.00	16.67	0.00	8.33	33.33	0.00	0.00	0.00	16.67
MDS/Qantel (18)	0.00	0.00	5.56	0.00	0.00	0.00	11.11	0.00	0.00	38.89	0.00	0.00	11.11	0.00	0.00	0.00	33.33
Microdata (78)	2.56	1.28	3.85	1.28	0.00	7.69	7.69	2.56	1.28	23.08	0.00	5.13	24.36	1.28	1.28	1.28	15.38
NCR (79)	5.06	0.00	3.80	10.13	0.00	6.33	15.19	0.00	1.27	26.58	2.53	1.27	16.46	3.80	1.27	0.00	6.33
Perkin-Elmer (21)	4.76	0.00	0.00	4.76	9.52	4.76	9.52	4.76	0.00	19.05	0.00	0.00	14.29	14.29	4.76	0.00	9.52
Prime (116)	2.59	1.72	4.31	17.24	16.38	4.31	1.72	1.72	0.00	15.52	0.00	3.45	5.17	6.03	1.72	5.17	12.93
Sperry (59)	1.69	0.00	1.69	8.47	0.00	10.71	5.08	3.39	0.00	33.90	1.69	0.00	16.64	3.39	1.69	1.69	8.47
Wang (135)	2.22	4.44	1.48	5.19	0.74	8.15	4.44	2.22	5.19	27.41	0.74	2.22	7.41	7.41	1.48	0.00	19.26
Other (42)	7.14	0.00	0.00	9.52	4.76	0.00	7.14	0.00	0.00	9.52	0.00	2.38	14.28	19.05	2.38	0.00	23.81
All Minicomputers (1970)	4.52	2.23	1.98	11.47	4.47	6.70	6.14	1.88	1.17	23.91	1.17	2.23	11.57	5.08	1.78	1.22	12.54

User Ratings of Minicomputer Systems

that a higher percentage of the IBM micros are installed by DEC users than by IBM users. The number of micros installed by sites using mini vendor's systems not listed were less than one percent each.

Industry and Applications

One of the questions we asked the users was "what type of industry describes your company?" Chart 4 shows the market penetration in each industry by manufacturer.

We also asked the users to specify their principal applications. Since 1982 the top six applications have remained the same: accounting/billing, payroll/personnel, order processing/inventory control, sales/distribution, purchasing, nd manufacturing. Chart 5 compares the user rankings of principal applications from 1983 and 1984. This year, education moved up from tenth to seventh place.

1984 Rankings	1983 Rankings
1. Accounting/Billing	1. Accounting/Billing
2. Payroll/Personnel	2. Payroll/Personnel
3. Order Processing/Inv. Control	3. Order Processing/Inv. Control
4. Sales/Distribution	4. Sales/Distribution
5. Purchasing	5. Purchasing
6. Manufacturing	6. Manufacturing
7. Education	7. Engr./Scientific
8. Engineering/Scientific	8. Math./Statistics
9. Math /Statistics	9. Health Care/Medical
10. Health Care/Medical	10. Education

Chart 5. User rankings of principal applications.

Software

The computer application development life cycle is a highly labor-intensive cycle. As labor costs climb, so does the cost of software development. As computers increase in capability and speed and as users become accustomed to results, the clamor for additional applications for "the computer" increases. Since many systems already face a two-year backlog in bringing up desirable applications, it is becoming more and more common for users to seek multiple sources for applications programs. And as the proprietary software industry increases in maturity and sophistication, "packaged software" becomes a desirable adjunct to in-house development.

We asked the users how they acquired their software, specifically, their application software. The 1984 user rankings of sources of applications programs compared with the 1983 rankings appear in Chart 6. Notice that programs from independent suppliers has moved up to position two, shoving the manufacturer's packages down one notch to position three.

1984	1983
1. In-house Personnel	1. In-house Personnel
2. Independent Supplier	2. Packaged Programs from Mfg
3. Packaged Programs from Mfg.	3. Independent Supplier
4. Contract Programming	4. Contract Programming
5. Manufacturer s Personnel	5. Manufacturer's Personnel

Chart 6. User rankings of sources of applications programs.

Another important question concerning software is "which programming language should I use?" Chart 7 illustrates which languages are used most frequently by minicomputer sites. This year Cobol comes out on top as the most frequently used language, followed by RPG (the primary language for IBM minis), and Basic.

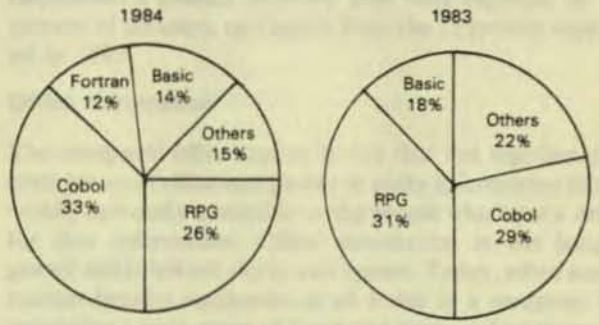

Chart 7. Primary programming languages

On the 1983 survey we asked if a data base management system and communications monitor were being used and if it was the manufacturer's package or an outside vendor's package. This year we took these questions a step farther and asked the user to name the package and then to assign a rating of Excellent, Good, Fair, or Poor to the package. Chart 8 shows the most widely used data base management packages, the number of responses received and the ratings for technical support (troubleshooting, documentation, and education), and the user's overall satisfaction with the package. Because so many different packages are available, we limited the following list to packages which received at least 10 responses.

Vendor and Package	Technical Support	Overall Satisfaction	No. Responses
Burroughs DMS-II	3.01	3.49	128*
Cincom Total	3.03	3.06	62*
DEC Datatrieve	2.94	2.94	18*
DEC DBMS	2.65	2.82	17*
Data General Infos	2.60	2.87	15
Honeo Info	2.68	3.00	22
Hewlett-Packard Image	3.31	3.45	124
IBM CPF	3.39	3.61	62
Microdata Reality	3.00	3.50	14
Poise DMS	3.20	3.30	10
Prime Information	2.82	3.41	17

*Chart 8. Data Base Management Packages. *Count includes both minicomputer and mainframe users.*

Communications monitors are not yet as prevalent on minicomputers as data base packages. Only two packages received more than 10 responses—Burroughs' MCS with 25 responses and Burroughs' NDL with 12 responses (these counts include both minicomputer and mainframe users). The ratings for the two monitors were very close. MCS received a weighted average rating of 3.00 for technical support, while NDL received a rating of 2.92. For overall satisfaction, MCS earned a 3.32 rating and NDL received a 3.42 rating.

User Ratings of Minicomputer Systems

Financial Alternatives

Users have three options by which they can acquire their computer system: purchase, rent/lease from the manufacturer, or lease from a third party. Each method of acquisition offers its own benefits and each method should be examined carefully to see which of these methods would be most beneficial to your company. By using the purchase option, the user can enjoy benefits such as the investment tax credit and depreciation schedule allowances. With the rapid advances in technology, however, many users feel that rental/lease from the manufacturer is the best option for them—because it allows them to upgrade faster to new systems. Also, many vendors include maintenance in the rent/lease price. The advantages a user can receive from third-party leasing are faster delivery and more attractive lease prices.

One of the questions we asked, therefore, was how users acquired their systems: outright purchase, rental/lease from the manufacturer, or third-party lease. Chart 9 shows how minicomputer users have acquired their systems for the last three years.

Method of Acquisition	1984	1983	1982
Purchase (%)	68	70	63
Rent/lease from Mfg.(%)	16	16	25
Lease from 3rd Party (%)	16	14	12

Chart 9. Financial alternatives.

Aquisitions and Replacements

We asked how users were planning on spending their enhancement/acquisition dollars in 1984. Chart 10 compares the user rankings of planned acquisitions for 1983 and 1984. Undoubtedly due to the increasing importance being placed on communications among systems and users, expansions to data communication facilities moved up from third to second place this year.

1984 Planned Acquisitions	1983 Planned Acquisitions
1. Expansions to Present Hardware (65%)	1. Expansions to Present Hardware (44%)
2. Expansions to Data Communications (44%)	2. Additional Proprietary Software (34%)
3. Additional Proprietary Software (41%)	3. Expansions to Data Communications (29%)
4. Additional Software from Mfg. (30%)	4. Additional Software from Mfg. (24%)
5. Additions to Distributed Processing Capabilities (15%)	5. Implement Disaster Recovery Plan (15%)

Chart 10. User rankings of planned acquisitions in 1984.

Disaster Recovery

The increasing dependence on computers has made many organizations aware of the vulnerability of their computer installations in the event of a fire, flood, or other disaster. We wanted to know how many survey respondents had implemented a disaster recovery plan and how many others were planning on doing so. Our survey shows that disaster recovery plans have been implemented by 51 percent of the minicomputer users. Interestingly, this is the same percentage reported last year by mini users. Plans to implement a disaster recovery plan were reported by 17 percent of the users, up slightly from the 15 percent reported in 1983.

Office Automation

The integrated office system is one that ties together discrete pieces of office equipment to make information more widely and easily accessible to the people who have a need for that information. Office automation is not longer geared solely toward clerks and typists. Today, office automation benefits employees at all levels in a company by providing a wide range of functions such as data processing, word processing, electronic mail, voice capabilities, business graphics, teleconferencing, image processing, and local area communications. To see how this trend toward the integrated office is shaping up, we asked the users whether they use integrated office functions or plan to in 1984. Thirty-three percent of the users have already made a commitment to the integrated office and another 17 percent plan to implement these functions in 1984. So a full 50 percent of the minicomputer users are working towards integrating their office functions.

User Satisfaction Ratings

Consistent with our belief that what users think is extremely important, we asked users to rate their computer systems and the associated software and vendor support by assigning a rating of Excellent, Good, Fair, or Poor to each of 14 factors: ease of operation, reliability of mainframe, reliability of peripherals, maintenance service (responsiveness and effectiveness), technical support (troubleshooting, education, and documentation), manufacturer's software (operating system, compilers and assemblers, and applications programs), ease of programming, ease of conversion, and overall satisfaction. All ratings are expressed in terms of Weighted Averages, which were calculated by assigning a weight of 4 to each user rating of Excellent, 3 to Good, 2 to Fair, and 1 to Poor, and then dividing the sum by the number of users who rated each factor.

The individual responses by vendor model appear in Table 1. In analyzing the ratings, we decided to see how many systems could meet the following criteria for special merit: a minimum of 20 user responses, an overall satisfaction

	Overall Satisfaction	Lowest Score	No. of Responses
Data General MV	3.31	2.86	43
DEC VAX-11	3.42	2.91	242
HP 3000	3.47	2.94	157
IBM System/34	3.35	2.90	148
IBM System/36	3.57	3.08	67
IBM System/38	3.47	2.63	222

Chart 11. Systems of special merit.

User Ratings of Minicomputer Systems

rating of at least 3.20, and a rating of no less than 2.80 in all other system rating categories. Chart 11 lists the six minicomputer systems that met this criteria.

For a number of other categories, we selected those systems that received a minimum of 20 responses and a rating of at least 3.50. Charts 12-14 show the systems that met these criteria for ease of operation, reliability of system and peripherals, and operating system.

Ease of Operation	Weighted Average	No. of Responses
Burroughs B 1900	3.55	143
DEC VAX-11	3.53	242
IBM System/36	3.63	67
Microdata Reality	3.63	57
Microdata Sequel	3.71	21
Wang VS	3.74	135

Chart 12. Systems given 3.50 rating for ease of operation.

Reliability of System	Weighted Average	No. of Responses
Data General Eclipse	3.56	56
DEC PDP-11	3.55	137
DEC VAX-11	3.58	242
HP 3000	3.70	157
IBM System/34	3.84	148
IBM System/36	3.75	67
IBM System/38	3.75	222
NCR 9000	3.55	67
Perkin-Elmer 3200	3.52	21
Prime 50 Series	3.60	116
Wang VS	3.74	135
Reliability of Peripherals		
HP 3000	3.70	157
IBM System/34	3.83	148
IBM System/36	3.75	67
IBM System/38	3.75	222
NCR 9000	3.50	67

Chart 13. Reliability of system and peripherals.

Operating System	Weighted Average	No. of Responses
Burroughs B 1900	3.57	143
DEC VAX-11	3.52	242
IBM System/36	3.54	67
IBM System/38	3.55	222
Microdata Reality	3.66	57
Microdata Sequel	3.75	21

Chart 14. Systems with a 3.50 rating for operating system.

Vendor service and support are key areas when considering a computer system. Although users have no control over the effectiveness of maintenance service, they can influence promptness of maintenance service by spelling out their requirements in their contract with the vendor. Chart 15 lists those vendors that received the highest overall ratings for maintenance service and technical support. To be listed in this chart, the vendor had to have a minimum of 20 user responses and a rating of at least 3.50 for maintenance service and 3.00 for technical support. Through the years that Datapro has been conducting this survey, we have found that the area of technical support usually receives the lowest ratings from the users. We felt, therefore, that any vendor receiving a rating of 3.00 in technical support was deserving of special mention. No vendor received a 3.00 in all three areas of technical support; no vendor rated a 3.00 for education.

Maintenance Service	Weighted Average	No. of Responses
Responsiveness:		
Hewlett-Packard	3.54	166
NCR	3.56	80
Effectiveness:		
Hewlett-Packard	3.54	166
NCR	3.52	80
Technical Support		
Troubleshooting:		
Hewlett-Packard	3.17	166
IBM	3.04	471
Documentation:		
IBM	3.02	471

Chart 15. Vendors receiving highest ratings for service and support.

Expectations and Recommendations

We asked the computer users "Did the system do what you expected it to do?" Ninety-two percent answered "yes", four percent said "no", and another four percent said "haven't decided."

The final question on the survey asked the users whether they would recommend the system to another user. Eighty-nine percent answered they would recommend the system, five percent said they would not, and six percent were undecided. These responses represent a slight improvement over 1983, when only 86 percent answered they would recommend the system, 7 percent said they would not, and the remaining 7 percent were undecided.

THANK YOU

Datapro extends a sincere thanks to all for responding so enthusiastically to our 1984 survey of user experiences with computer systems. Without your participation the survey could not have been the success it is, and we hope that this compendium of the opinions of user colleagues will be of significant value to you. We look forward to hearing from you again next year. □

User Ratings of

Minicomputer Systems

JULY 1984

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Survey Item \ Manufacturer and Model	Burroughs B 1800	Burroughs B 90	Burroughs B 900	Burroughs B 1900	Data General CS Series	Data General Eclipse	Data General Eclipse/MV	Datapoint All Models
No. of User Responses	5	18	5	143	23	56	43	34
Avg. Life of System (months)	52.5	40.5	37.4	39.5	50.8	55.4	23.4	30.3
Acquisition Method (%)								
Purchase	60.00	77.78	60.00	50.70	82.61	85.71	81.40	64.71
Rental or Lease from Mfr.	20.00	5.56	40.00	40.85	0.00	1.79	2.33	26.47
Lease from 3rd Party	20.00	16.67	0.00	8.45	17.39	12.50	16.28	8.82
Principal Applications (%)								
Accounting/Billing	80.00	72.22	60.00	79.02	69.57	67.86	69.77	76.47
Banking—Check Processing/Loans/Savings	20.00	27.78	0.00	12.59	8.70	3.57	0.00	0.00
Construction/Architecture	0.00	0.00	0.00	1.40	0.00	8.93	0.00	0.00
Education—Scheduling/Administration	20.00	0.00	0.00	17.48	17.39	7.14	20.93	2.94
Engineering/Scientific	0.00	0.00	0.00	4.20	0.00	19.64	9.30	2.94
Health Care/Medical	0.00	11.11	20.00	8.39	17.39	21.43	4.65	5.88
Insurance	0.00	5.56	0.00	4.90	13.04	7.14	4.65	5.88
Manufacturing	60.00	0.00	0.00	20.98	8.70	12.50	16.28	11.76
Mathematics/Statistics	0.00	5.56	0.00	4.90	4.35	12.50	13.95	5.88
Order Processing/Inventory Control	80.00	38.89	40.00	46.15	34.78	41.07	51.16	41.18
Payroll/Personnel	60.00	55.56	60.00	72.03	39.13	42.86	48.84	47.06
Petroleum/Fuel Analysis	0.00	5.56	0.00	0.70	4.35	1.79	2.33	0.00
Process Control	20.00	0.00	0.00	2.10	0.00	3.57	2.33	8.82
Purchasing	60.00	27.78	60.00	38.46	13.04	21.43	30.23	17.65
Sales/Distribution	20.00	33.33	40.00	27.27	21.74	16.07	25.58	44.12
Other	0.00	22.22	40.00	16.08	13.04	32.14	27.91	17.65
Source of Applications Programs (%)								
In-house Personnel	80.00	16.67	60.00	81.12	78.26	66.07	86.05	94.12
"Packaged" Programs from Manufacturer	60.00	44.44	20.00	31.47	17.39	21.43	23.26	5.88
Contract Programming	0.00	11.11	40.00	27.97	34.78	28.57	32.56	32.35
Manufacturer's Personnel	0.00	16.67	0.00	3.50	0.00	1.79	2.33	0.00
Independent Suppliers	80.00	50.00	20.00	35.66	56.52	46.43	46.51	17.65
Using Data Base Management System (%)	60.00	11.11	0.00	52.45	15.79	35.71	41.46	8.82
Planning a Data Base Management System in 1984	20.00	11.11	20.00	18.88	15.79	8.93	17.07	11.76
Manufacturer's Package	100.00	0.00	0.00	100.00	100.00	100.00	100.00	0.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Using Communications Monitor (%)	0.00	0.00	25.00	23.91	5.26	5.66	17.95	9.09
Planning a Communications Monitor in 1984	0.00	0.00	0.00	3.62	10.53	1.89	12.82	0.00
Manufacturer's Package	0.00	0.00	0.00	95.46	0.00	0.00	0.00	0.00
Outside Vendor's Package	0.00	0.00	0.00	4.54	0.00	0.00	0.00	0.00
Using Integrated Office Automation Functions (%)	0.00	26.67	0.00	14.49	25.00	29.41	51.22	65.63
Planning Office Automation Functions in 1984	0.00	0.00	25.00	19.57	10.00	15.69	19.51	9.38
Have a Disaster Recovery Plan (%)	80.00	55.56	60.00	51.43	47.83	61.11	39.53	60.61
Plan to in 1984	0.00	0.00	0.00	15.71	13.04	14.81	27.91	6.06

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Burroughs B 1800	Burroughs B 90	Burroughs B 900	Burroughs B 1900	Data General CS Series	Data General Eclipse	Data General Eclipse/MV	Datapoint All Models	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
60.00	27.78	40.00	25.87	17.39	14.29	48.84	50.00	Additional Software from the Manufacturer
40.00	16.67	20.00	30.07	43.48	53.57	41.86	23.53	Proprietary Software from Other Suppliers
60.00	11.11	40.00	52.45	8.70	28.57	58.14	52.94	Expansions to Data Communications Facilities
20.00	5.56	40.00	21.68	8.70	17.86	9.30	17.65	Distributed Processing Capabilities
60.00	22.22	40.00	58.74	43.48	51.79	74.42	70.59	Expansions to Present Hardware
0.00	5.56	0.00	10.49	0.00	7.14	16.28	8.82	Business Graphics
0.00	0.00	0.00	8.39	8.70	25.00	18.60	5.88	Power Conditioning Systems
								System Ratings (4.0-1.0)
4.00	3.22	3.40	3.55	3.30	3.33	3.42	3.12	Ease of Operation
3.80	3.50	3.60	3.46	3.26	3.56	3.49	3.41	Reliability of Mainframe
3.60	3.17	3.20	3.13	3.18	3.33	3.36	3.45	Reliability of Peripherals
								Maintenance Service:
3.80	3.39	3.40	3.28	3.39	3.04	3.40	3.47	Responsiveness
3.60	3.22	2.80	3.03	3.13	2.98	3.37	3.12	Effectiveness
								Technical Support:
3.20	3.06	2.60	2.64	2.59	2.68	2.93	2.79	Trouble-shooting
2.80	2.82	2.80	2.69	2.59	2.69	2.95	2.71	Education
2.80	2.78	2.40	2.40	2.55	2.52	2.86	2.53	Documentation
								Manufacturer's Software:
4.00	3.19	4.00	3.57	3.14	3.30	3.38	3.18	Operating System
3.60	3.25	3.80	3.34	3.09	3.11	3.15	3.00	Compilers & Assemblers
3.20	2.67	2.67	2.90	2.71	2.88	3.18	2.52	Applications Programs
4.00	2.85	3.80	3.30	3.32	3.22	3.32	3.06	Ease of Programming
3.20	2.80	3.75	3.22	2.95	2.88	3.17	2.94	Ease of Conversion
3.40	3.13	3.40	3.25	3.05	3.14	3.31	3.15	Overall Satisfaction
								Additional Ratings (4.0-1.0)
3.20	3.10	3.40	3.32	2.91	3.06	3.20	2.97	Ease of Reconfiguration
3.33	2.89	3.25	2.94	2.60	2.69	2.65	2.10	Compatibility of Hardware carried over from other systems
3.20	2.89	3.33	3.12	2.60	2.60	2.84	2.23	Compatibility of Programs/data carried over from other systems
3.20	2.92	3.25	2.98	2.94	2.92	3.27	3.21	Power/energy Efficiency
3.00	2.70	3.33	2.87	2.78	2.68	2.92	2.07	Productivity Aids help keep programming costs low
2.80	2.60	2.50	2.60	2.67	2.63	2.95	2.47	Software/Support promised by vendor
3.80	3.38	3.00	3.04	2.91	3.02	3.17	3.12	Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
2.60	2.83	3.00	2.73	2.74	2.90	3.09	2.68	Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
3.00	2.76	3.00	2.88	2.78	2.80	3.02	2.88	Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
100.00	94.44	100.00	90.91	100.00	96.36	83.72	85.29	Yes
0.00	5.56	0.00	5.59	0.00	1.82	6.98	11.76	No
0.00	0.00	0.00	3.50	0.00	1.82	9.30	2.94	Undecided
								Would you recommend system to another user? (%)
100.00	88.89	80.00	86.01	86.36	80.36	86.05	82.35	Yes
0.00	5.56	0.00	4.90	9.09	8.93	4.65	14.71	No
0.00	5.56	20.00	9.09	4.55	10.71	9.30	2.94	Undecided

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Survey Item / Manufacturer and Model	Digital Equipment PDP-11	Digital Equipment VAX-11	Four-Phase All Models	Harris All Models	Hewlett-Packard 1000	Hewlett-Packard 3000	Honeywell DPS 6	IBM Series 1
No. of User Responses	137	242	31	7	9	157	33	15
Avg. Life of System (months)	53.1	36.9	62.6	34.0	68.4	43.4	33.3	47.8
Acquisition Method (%)								
Purchase	79.85	75.42	3.23	71.43	88.89	78.85	75.76	100.00
Rental or Lease from Mfr.	4.48	4.58	61.29	0.00	11.11	10.90	6.06	0.00
Lease from 3rd Party	15.67	20.00	35.48	28.57	0.00	10.26	18.18	0.00
Principal Applications (%)								
Accounting/Billing	65.69	50.83	67.74	42.86	33.33	72.61	72.73	40.00
Banking—Check Processing/Loans/Savings	2.92	0.83	0.00	0.00	0.00	1.91	3.03	0.00
Construction/Architecture	1.46	4.13	3.23	14.29	0.00	1.91	3.03	0.00
Education—Scheduling/Administration	29.93	30.99	6.45	28.57	0.00	21.66	9.09	6.67
Engineering/Scientific	18.25	44.21	0.00	57.14	66.67	12.74	3.03	6.67
Health Care/Medical	8.03	6.20	41.94	14.29	0.00	4.46	12.12	13.33
Insurance	0.73	4.13	6.45	0.00	0.00	0.64	6.06	0.00
Manufacturing	13.87	14.88	6.45	0.00	0.00	29.94	15.15	20.00
Mathematics/Statistics	16.06	26.86	9.68	85.71	44.44	7.64	6.06	6.67
Order Processing/Inventory Control	39.42	24.38	25.81	14.29	11.11	49.04	42.42	60.00
Payroll/Personnel	42.34	35.95	38.71	28.57	33.33	56.05	51.52	13.33
Petroleum/Fuel Analysis	0.73	1.65	0.00	0.00	0.00	1.91	0.00	6.67
Process Control	8.76	6.20	3.23	0.00	11.11	8.28	3.03	0.00
Purchasing	24.09	17.77	12.90	28.57	0.00	36.94	18.18	20.00
Sales/Distribution	18.25	13.22	3.23	0.00	0.00	31.85	33.33	26.67
Other	21.17	19.01	25.81	0.00	22.22	24.84	30.30	26.67
Source of Applications Programs (%)								
In-house Personnel	80.29	86.36	70.97	71.43	77.78	86.62	84.85	60.00
"Packaged" Programs from Manufacturer	37.96	38.84	38.71	71.43	22.22	32.48	42.42	20.00
Contract Programming	25.55	16.53	25.81	14.29	22.22	31.85	36.36	40.00
Manufacturer's Personnel	2.19	2.07	3.23	0.00	0.00	0.00	6.06	0.00
Independent Suppliers	49.64	59.92	25.81	42.86	33.33	49.68	45.45	20.00
Using Data Base Management System (%)	37.12	41.35	10.00	57.14	44.44	85.16	34.38	40.00
Planning a Data Base Management System in 1984	6.06	14.77	3.33	14.29	11.11	7.10	15.63	6.67
Manufacturer's Package	60.00	46.55	0.00	0.00	100.00	100.00	0.00	0.00
Outside Vendor's Package	40.00	53.45	0.00	100.00	0.00	0.00	100.00	0.00
Using Communications Monitor (%)	4.72	7.83	13.33	14.29	0.00	7.24	10.00	6.67
Planning a Communications Monitor in 1984	7.09	8.26	3.33	14.29	0.00	6.58	10.00	0.00
Manufacturer's Package	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Using Integrated Office Automation Functions (%)	35.34	41.99	55.17	28.57	22.22	35.14	31.25	20.00
Planning Office Automation Functions in 1984	12.03	12.12	6.90	14.29	11.11	22.97	0.00	6.67
Have a Disaster Recovery Plan (%)	51.11	47.70	66.67	57.14	44.44	49.35	61.29	33.33
Plan to in 1984	13.33	18.41	6.67	14.29	0.00	20.78	12.90	13.33

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Digital Equipment PDP-11	Digital Equipment VAX-11	Four-Phase All Models	Harris All Models	Hewlett-Packard 1000	Hewlett-Packard 3000	Honeywell DPS 6	IBM Series 1	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
23.36	39.26	16.13	42.86	22.22	32.48	36.36	46.67	Additional Software from the Manufacturer
38.69	59.09	9.68	42.86	11.11	49.04	27.27	33.33	Proprietary Software from Other Suppliers
42.34	52.07	29.03	57.14	22.22	50.32	45.45	53.33	Expansions to Data Communications Facilities
15.33	19.01	12.90	28.57	11.11	19.11	15.15	20.00	Distributed Processing Capabilities
69.34	71.90	38.71	57.14	33.33	75.16	63.64	46.67	Expansions to Present Hardware
13.14	17.36	3.23	57.14	0.00	15.92	3.03	20.00	Business Graphics
9.49	10.33	6.45	28.57	0.00	9.55	6.06	6.67	Power Conditioning Systems
								System Ratings (4.0-1.0)
3.44	3.53	3.23	3.00	2.89	3.48	3.31	3.00	Ease of Operation
3.55	3.58	3.19	2.71	3.56	3.70	3.03	3.53	Reliability of Mainframe
3.42	3.33	2.87	2.50	3.13	3.61	2.91	3.29	Reliability of Peripherals
								Maintenance Service:
3.44	3.27	3.26	3.00	3.78	3.52	3.28	3.40	Responsiveness
3.37	3.17	3.13	2.71	3.67	3.53	3.13	3.60	Effectiveness
								Technical Support:
3.03	2.91	2.94	2.71	3.11	3.17	2.71	3.00	Trouble-shooting
2.78	2.92	2.77	2.00	2.56	3.00	2.65	2.93	Education
2.91	2.99	2.58	2.00	2.33	2.94	2.65	2.93	Documentation
								Manufacturer's Software:
3.47	3.52	2.96	2.86	3.25	3.46	3.17	2.93	Operating System
3.27	3.45	2.88	2.14	3.25	3.38	3.25	2.92	Compilers & Assemblers
3.09	3.00	2.65	2.50	2.86	3.06	2.65	2.77	Applications Programs
3.20	3.31	3.09	2.43	3.13	3.27	3.03	2.85	Ease of Programming
2.94	3.07	2.45	2.50	2.50	3.15	2.80	3.00	Ease of Conversion
3.31	3.42	3.07	2.71	2.88	3.47	2.97	3.14	Overall Satisfaction
								Additional Ratings (4.0-1.0)
2.99	3.24	2.73	2.57	2.33	3.26	3.03	3.15	Ease of Reconfiguration
3.13	3.11	2.24	2.14	2.56	2.80	2.77	2.69	Compatibility of Hardware carried over from other systems
2.64	2.81	2.41	2.71	2.22	3.04	2.52	2.54	Compatibility of Programs/data carried over from other systems
2.88	2.94	2.96	2.71	2.75	3.23	3.10	3.31	Power/energy Efficiency
2.69	2.92	2.59	2.14	2.56	3.08	2.59	2.85	Productivity Aids help keep programming costs low
2.87	2.90	2.68	2.43	3.22	3.01	2.58	2.46	Software/Support promised by vendor
3.09	3.20	3.14	2.86	2.22	3.31	2.61	3.00	Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
2.83	2.63	2.89	2.86	2.78	2.99	2.79	2.67	Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
2.78	2.76	2.86	2.71	2.78	2.95	2.84	3.00	Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
90.44	93.39	100.00	51.14	100.00	98.73	84.85	73.33	Yes
2.94	2.48	0.00	28.57	0.00	0.00	6.06	13.33	No
6.62	4.13	0.00	14.29	0.00	1.27	9.09	13.33	Undecided
								Would you recommend system to another user? (%)
83.82	94.63	87.10	57.14	66.67	93.59	75.00	53.33	Yes
7.35	1.65	6.45	14.29	11.11	1.92	6.25	33.33	No
8.82	3.72	6.45	28.57	22.22	4.49	18.75	13.33	Undecided

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Survey Item \ Manufacturer and Model	IBM System/23	IBM System/34	IBM System/36	IBM System/38	IBM 8100	MAI/Basic Four All Models	MDS/Qantel All Models	Microdata Reality
No. of User Responses	13	148	67	222	6	12	18	57
Avg. Life of System (months)	36.0	55.2	14.5	35.6	53.0	38.7	48.3	53.1
Acquisition Method (%)								
Purchase	92.31	71.62	62.69	61.54	60.00	83.33	55.56	77.19
Rental or Lease from Mfr.	7.69	18.24	16.42	11.31	40.00	16.67	16.67	7.02
Lease from 3rd Party	0.00	10.14	20.90	27.15	0.00	0.00	27.78	15.79
Principal Applications (%)								
Accounting/Billing	92.31	89.19	86.57	87.84	33.33	83.33	94.44	94.74
Banking—Check Processing/Loans/Savings	0.00	5.41	2.99	3.15	0.00	0.00	0.00	7.02
Construction/Architecture	0.00	3.38	2.99	3.60	16.67	16.67	11.11	5.26
Education—Scheduling/Administration	0.00	8.78	10.45	7.66	16.67	0.00	0.00	1.75
Engineering/Scientific	0.00	4.05	4.48	5.41	33.33	0.00	0.00	1.75
Health Care/Medical	7.69	5.41	2.99	6.76	0.00	0.00	22.22	1.75
Insurance	15.38	3.38	7.46	5.86	0.00	0.00	0.00	10.53
Manufacturing	15.38	22.30	28.36	41.44	50.00	25.00	50.00	24.56
Mathematics/Statistics	0.00	5.41	5.97	7.21	16.67	8.33	0.00	5.26
Order Processing/Inventory Control	15.38	52.70	59.70	65.32	50.00	50.00	83.33	64.91
Payroll/Personnel	61.54	66.22	68.66	72.52	33.33	58.33	77.78	50.88
Petroleum/Fuel Analysis	0.00	1.35	2.99	2.25	0.00	8.33	0.00	0.00
Process Control	7.69	4.73	4.48	4.50	16.67	8.33	0.00	3.51
Purchasing	15.38	27.70	34.33	44.14	33.33	33.33	55.56	43.86
Sales/Distribution	30.77	41.89	44.78	50.90	50.00	41.67	61.11	49.12
Other	38.46	16.89	13.43	14.41	50.00	8.33	16.67	14.04
Source of Applications Programs (%)								
In-house Personnel	38.46	64.86	83.58	95.50	83.33	91.67	27.78	59.65
"Packaged" Programs from Manufacturer	38.46	37.16	34.33	41.44	33.33	50.00	88.89	31.58
Contract Programming	15.38	40.54	35.82	34.23	33.33	33.33	50.00	50.88
Manufacturer's Personnel	0.00	3.38	0.00	0.90	0.00	8.33	22.22	0.00
Independent Suppliers	46.15	39.19	32.84	35.14	16.67	25.00	27.78	42.11
Using Data Base Management System (%)	23.08	5.67	3.13	69.81	50.00	45.45	55.56	75.93
Planning a Data Base Management System in 1984	7.69	9.22	9.38	2.36	16.67	27.27	0.00	0.00
Manufacturer's Package	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Using Communications Monitor (%)	7.69	3.65	0.00	13.00	33.33	0.00	5.56	8.00
Planning a Communications Monitor in 1984	7.69	10.22	14.06	9.50	16.67	18.18	5.56	0.00
Manufacturer's Package	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Using Integrated Office Automation Functions (%)	33.33	25.18	30.65	30.54	16.67	66.67	35.29	20.00
Planning Office Automation Functions in 1984	25.00	17.99	22.58	23.65	16.67	0.00	11.76	22.00
Have a Disaster Recovery Plan (%)	46.15	49.32	53.73	53.88	60.00	25.00	72.22	56.14
Plan to in 1984	7.69	14.38	19.40	21.00	0.00	41.67	11.11	12.28

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

IBM System/23	IBM System/34	IBM System/36	IBM System/38	IBM 8100	MAI/Basic Four All Models	MDS/Qantel All Models	Microdata Reality	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
15.38	14.86	32.84	24.77	33.33	25.00	66.67	19.30	Additional Software from the Manufacturer
38.46	43.24	38.81	42.79	33.33	25.00	33.33	33.33	Proprietary Software from Other Suppliers
15.38	22.97	49.25	50.90	50.00	50.00	38.89	28.07	Expansions to Data Communications Facilities
0.00	2.70	17.91	11.26	16.67	41.67	22.22	7.02	Distributed Processing Capabilities
23.08	56.08	58.21	77.48	50.00	50.00	72.22	57.89	Expansions to Present Hardware
0.00	5.41	11.94	10.81	0.00	25.00	27.78	8.77	Business Graphics
0.00	2.70	4.48	11.26	0.00	8.33	0.00	10.53	Power Conditioning Systems
								System Ratings (4.0-1.0)
3.00	3.48	3.63	3.49	3.33	3.42	3.56	3.63	Ease of Operation
3.31	3.83	3.75	3.75	3.67	3.25	3.72	3.32	Reliability of Mainframe
3.15	3.68	3.67	3.52	3.33	3.00	3.67	3.09	Reliability of Peripherals
								Maintenance Service:
3.08	3.40	3.45	3.55	3.50	3.33	3.61	3.40	Responsiveness
3.15	3.46	3.40	3.55	3.33	3.08	3.61	3.27	Effectiveness
								Technical Support:
2.83	3.06	3.17	3.01	3.17	2.75	3.11	2.89	Trouble-shooting
2.42	2.92	3.23	2.97	3.17	2.42	2.89	2.64	Education
2.75	2.97	3.28	3.00	3.17	2.00	2.71	2.58	Documentation
								Manufacturer's Software:
3.00	3.39	3.54	3.55	3.33	2.92	3.44	3.66	Operating System
3.00	3.40	3.57	3.55	3.40	2.90	3.39	3.35	Compilers & Assemblers
2.70	2.90	3.08	2.83	3.33	2.91	3.17	2.98	Applications Programs
2.92	3.18	3.45	2.67	3.00	3.50	3.31	3.46	Ease of Programming
2.67	2.99	3.52	2.64	3.00	3.00	3.53	3.23	Ease of Conversion
2.67	3.35	3.57	3.47	3.33	3.08	3.33	3.34	Overall Satisfaction
								Additional Ratings (4.0-1.0)
2.67	3.01	3.60	2.92	3.50	3.09	3.76	3.24	Ease of Reconfiguration
2.09	2.78	3.54	2.65	3.75	2.82	2.63	2.84	Compatibility of Hardware carried over from other systems
2.64	2.69	3.53	2.50	3.33	2.50	2.60	2.68	Compatibility of Programs/data carried over from other systems
2.73	3.00	3.48	3.19	3.75	3.00	3.50	2.94	Power/energy Efficiency
2.50	2.83	3.33	3.53	3.25	2.60	3.38	2.92	Productivity Aids help keep programming costs low
2.45	2.87	3.23	3.08	3.50	2.45	2.94	2.64	Software/Support promised by vendor
2.69	3.10	3.39	3.28	2.67	2.75	3.44	3.39	Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
2.92	2.97	3.09	2.93	3.20	2.75	3.00	3.00	Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
2.45	2.93	3.03	2.99	3.20	2.73	2.88	2.78	Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
76.92	93.92	95.52	95.48	100.00	83.33	83.33	89.47	Yes
23.08	1.35	1.49	2.26	0.00	8.33	11.11	3.51	No
0.00	4.73	2.99	2.26	0.00	8.33	5.56	7.02	Undecided
								Would you recommend system to another user? (%)
69.23	95.27	97.01	98.20	100.00	75.00	88.89	87.72	Yes
30.77	1.35	0.00	0.90	0.00	16.67	5.56	7.02	No
0.00	3.38	2.99	0.90	0.00	8.33	5.56	5.26	Undecided

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Survey Item \ Manufacturer and Model	Microdata Sequel	NCR 9000	NCR 9300	Perkin-Elmer 3200	Prime 50 Series	Sperry System 80	Wang VS	Minicomputers (Other Models)
No. of User Responses	21	67	13	21	116	59	135	42
Avg. Life of System (months)	23.3	31.3	10.9	41.0	34.8	35.1	35.8	54.4
Acquisition Method (%)								
Purchase	57.14	47.76	76.92	80.95	56.90	37.29	70.15	76.19
Rental or Lease from Mfr.	0.00	34.33	7.69	4.76	28.45	52.54	14.18	4.76
Lease from 3rd Party	42.86	17.91	15.38	14.29	14.66	10.17	15.67	19.05
Principal Applications (%)								
Accounting/Billing	100.00	94.03	92.31	47.62	58.62	89.83	77.78	71.43
Banking—Check Processing/Loans/Savings	0.00	2.99	15.38	0.00	0.86	0.00	3.70	16.67
Construction/Architecture	9.52	5.97	7.69	4.76	7.76	0.00	2.96	4.76
Education—Scheduling/Administration	4.76	10.45	15.38	14.29	22.41	11.86	8.15	21.43
Engineering/Scientific	4.76	1.49	0.00	23.81	36.21	6.78	6.67	16.67
Health Care/Medical	33.33	19.40	15.38	9.52	2.59	6.78	8.15	16.67
Insurance	14.29	2.99	7.69	0.00	2.59	8.47	5.93	9.52
Manufacturing	38.10	19.40	30.77	14.29	14.66	32.20	20.00	26.19
Mathematics/Statistics	4.76	5.97	15.38	28.57	29.31	1.69	5.93	14.28
Order Processing/Inventory Control	57.14	62.69	69.23	42.86	35.34	69.49	51.85	40.47
Payroll/Personnel	90.48	79.10	76.92	9.52	47.41	72.88	49.63	38.09
Petroleum/Fuel Analysis	0.00	0.00	0.00	0.00	2.59	3.39	4.44	2.38
Process Control	0.00	7.46	15.38	14.29	2.59	1.69	4.44	9.52
Purchasing	71.43	32.84	30.77	33.33	31.03	45.76	30.37	33.33
Sales/Distribution	47.62	29.85	30.77	38.10	22.41	49.15	35.56	40.47
Other	19.05	13.43	7.69	14.29	28.45	15.25	22.96	23.38
Source of Applications Programs (%)								
In-house Personnel	80.95	68.66	53.85	80.95	84.48	93.22	86.67	83.33
"Packaged" Programs from Manufacturer	42.86	56.72	69.23	4.76	30.17	28.81	17.78	38.10
Contract Programming	38.10	40.30	23.08	33.33	19.83	23.73	34.07	21.43
Manufacturer's Personnel	4.76	4.48	0.00	0.00	0.86	8.47	0.74	4.76
Independent Suppliers	61.90	32.84	23.08	23.81	57.76	20.34	43.70	30.95
Using Data Base Management System (%)	85.71	6.45	15.38	66.67	52.63	27.12	6.77	39.02
Planning a Data Base Management System in 1984	0.00	8.06	38.46	0.00	13.16	10.17	13.53	9.76
Manufacturer's Package	100.00	0.00	0.00	100.00	56.52	100.00	0.00	—
Outside Vendor's Package	0.00	0.00	0.00	0.00	32.61	0.00	100.00	—
Using Communications Monitor (%)	0.00	4.92	7.69	14.29	9.09	15.25	8.33	12.19
Planning a Communications Monitor in 1984	9.52	3.28	0.00	4.76	5.45	8.47	9.09	7.32
Manufacturer's Package	0.00	0.00	0.00	0.00	0.00	100.00	0.00	—
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—
Using Integrated Office Automation Functions (%)	33.33	23.33	15.38	10.00	37.27	12.28	61.65	26.83
Planning Office Automation Functions in 1984	38.10	13.33	38.46	20.00	14.55	15.79	13.53	14.63
Have a Disaster Recovery Plan (%)	55.00	62.50	33.33	33.33	48.70	52.63	38.81	48.72
Plan to in 1984	35.00	14.06	25.00	14.29	19.13	17.54	20.90	20.51

User Ratings of Minicomputer Systems

TABLE 1. MINICOMPUTERS

Microdata Sequel	NCR 9000	NCR 9300	Perkin-Elmer 3200	Prime 50 Series	Sperry System 80	Wang VS	Minicomputers (Other Models)	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
47.62	29.85	46.15	38.10	26.72	28.81	31.11	40.47	Additional Software from the Manufacturer
47.62	28.36	38.46	57.14	40.52	32.20	44.44	35.71	Proprietary Software from Other Suppliers
57.14	32.84	7.69	23.81	51.72	45.76	50.37	35.71	Expansions to Data Communications Facilities
23.81	11.94	0.00	9.52	21.55	18.64	20.00	7.14	Distributed Processing Capabilities
76.19	55.22	38.46	61.90	68.10	72.88	75.56	50.00	Expansions to Present Hardware
23.81	7.46	0.00	9.52	24.14	1.69	16.30	14.28	Business Graphics
14.29	4.48	15.38	9.52	18.97	6.78	11.85	7.14	Power Conditioning Systems
								System Ratings (4.0-1.0)
3.71	3.40	3.69	2.76	3.41	3.34	3.74	3.51	Ease of Operation
3.38	3.55	3.85	3.52	3.60	3.39	3.53	3.64	Reliability of Mainframe
3.29	3.50	3.67	3.38	3.37	3.19	3.26	3.56	Reliability of Peripherals
								Maintenance Service:
3.43	3.55	3.62	3.10	3.39	3.42	3.11	3.37	Responsiveness
3.19	3.46	3.85	2.95	3.17	3.32	3.06	3.22	Effectiveness
								Technical Support:
3.00	2.89	3.23	2.67	2.70	2.80	2.63	3.26	Trouble-shooting
2.62	2.89	3.15	2.37	2.73	2.45	2.64	3.13	Education
2.86	2.65	3.00	2.43	2.60	2.44	2.55	2.85	Documentation
								Manufacturer's Software:
3.75	3.19	3.54	2.81	3.33	3.19	3.26	3.45	Operating System
3.60	3.18	3.50	2.86	3.00	3.22	3.37	3.31	Compilers & Assemblers
3.38	2.73	3.25	2.45	2.78	2.70	2.98	2.90	Applications Programs
3.80	3.37	3.31	2.85	3.25	3.17	3.62	3.24	Ease of Programming
3.45	3.14	3.31	2.94	3.19	2.78	3.44	2.89	Ease of Conversion
3.65	3.24	3.54	2.90	3.29	2.98	3.34	3.39	Overall Satisfaction
								Additional Ratings (4.0-1.0)
3.43	3.17	3.77	2.95	3.27	2.92	3.54	3.03	Ease of Reconfiguration
3.20	2.89	3.58	2.44	3.30	2.26	2.21	2.90	Compatibility of Hardware carried over from other systems
2.95	2.84	3.54	2.95	3.09	2.95	2.97	2.69	Compatibility of Programs/data carried over from other systems
3.05	3.08	3.85	2.84	3.12	3.15	3.07	3.16	Power/energy Efficiency
3.22	2.82	3.23	2.26	2.97	2.83	3.38	2.68	Productivity Aids help keep programming costs low
3.05	2.66	3.23	2.26	2.61	2.60	2.61	2.95	Software/Support promised by vendor
3.24	3.11	3.31	2.57	3.08	2.86	3.02	3.10	Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
3.00	2.92	2.85	2.90	3.10	2.81	2.57	3.05	Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
3.05	2.77	2.75	2.80	3.02	2.79	2.60	2.83	Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
95.24	91.04	92.31	76.19	93.04	81.36	92.59	92.86	Yes
0.00	4.48	0.00	14.29	2.61	15.25	2.96	4.76	No
4.76	4.48	7.69	9.52	4.35	3.39	4.44	2.38	Undecided
								Would you recommend system to another user? (%)
100.00	83.58	100.00	61.90	91.38	76.27	91.85	84.61	Yes
0.00	5.97	0.00	23.81	3.45	10.17	1.48	5.13	No
0.00	10.45	0.00	14.29	5.17	13.56	6.67	10.26	Undecided

User Ratings of Minicomputer Systems

TABLE 2. MINICOMPUTER VENDOR SUMMARIES

Survey Item / Manufacturer and Model	Burroughs	Data General	Datapoint	Digital Equipment	Four-Phase	Harris	Hewlett-Packard	Honeywell
No. of User Responses	171	122	34	379	31	7	166	33
Avg. Life of System (months)	39.8	43.2	30.3	42.7	62.6	34.0	44.6	33.3
Acquisition Method (%)								
Purchase	54.12	83.61	64.71	77.01	3.23	71.43	79.39	75.76
Rental or Lease from Mfr.	36.47	1.64	26.47	4.55	61.29	0.00	10.91	6.06
Lease from 3rd Party	9.41	14.75	8.82	18.45	35.48	28.57	9.70	18.18
Principal Applications (%)								
Accounting/Billing	77.78	68.85	76.47	56.20	67.74	42.86	70.48	72.73
Banking—Check Processing/Loans/Savings	14.04	3.28	0.00	1.58	0.00	0.00	1.81	3.03
Construction/Architecture	1.17	4.10	0.00	3.17	3.23	14.29	1.81	3.03
Education—Scheduling/Administration	15.20	13.93	2.94	30.61	6.45	28.57	20.48	9.09
Engineering/Scientific	3.51	12.30	2.94	34.83	0.00	57.14	15.66	3.03
Health Care/Medical	8.77	14.75	5.88	6.86	41.94	14.29	4.22	12.12
Insurance	4.68	7.38	5.88	2.90	6.45	0.00	0.60	6.06
Manufacturing	19.30	13.11	11.76	14.51	6.45	0.00	28.31	15.15
Mathematics/Statistics	4.68	11.48	5.88	22.96	9.68	85.71	9.64	6.06
Order Processing/Inventory Control	46.20	43.44	41.18	29.82	25.81	14.29	46.99	42.42
Payroll/Personnel	69.59	44.26	47.06	38.26	38.71	28.57	54.82	51.52
Petroleum/Fuel Analysis	1.17	2.46	0.00	1.32	0.00	0.00	1.81	0.00
Process Control	2.34	2.46	8.82	7.12	3.23	0.00	8.43	3.03
Purchasing	38.60	22.95	17.65	20.05	12.90	28.57	34.94	18.18
Sales/Distribution	28.07	20.49	44.12	15.04	3.23	0.00	30.12	33.33
Other	16.96	27.05	17.65	19.79	25.81	0.00	24.70	30.30
Source of Applications Programs (%)								
In-house Personnel	73.68	75.41	94.12	84.17	70.97	71.43	86.14	84.85
"Packaged" Programs from Manufacturer	33.33	21.31	5.88	38.52	38.71	71.43	31.93	42.42
Contract Programming	25.73	31.15	32.35	19.79	25.81	14.29	31.33	36.36
Manufacturer's Personnel	4.68	1.64	0.00	2.11	3.23	0.00	0.00	6.06
Independent Suppliers	38.01	48.36	17.65	56.20	25.81	42.86	48.80	45.45
Using Data Base Management System (%)	46.78	34.48	8.82	39.84	10.00	57.14	82.93	34.38
Planning a Data Base Management System in 1984	18.13	12.93	11.76	11.65	3.33	14.29	7.32	15.63
Manufacturer's Package	100.00	100.00	0.00	49.30	0.00	0.00	100.00	0.00
Outside Vendor's Package	0.00	0.00	0.00	50.70	0.00	100.00	0.00	100.00
Using Communications Monitor (%)	20.73	9.91	9.09	6.72	13.33	14.29	6.88	10.00
Planning a Communications Monitor in 1984	3.05	7.21	0.00	7.84	3.33	14.29	6.25	10.00
Manufacturer's Package	100.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Using Integrated Office Automation Functions (%)	14.91	36.61	65.63	39.56	55.17	28.57	34.39	31.25
Planning Office Automation Functions in 1984	17.39	16.07	9.38	12.09	6.90	14.29	22.29	0.00
Have a Disaster Recovery Plan (%)	52.98	50.83	60.61	48.93	66.67	57.14	49.08	61.29
Plan to in 1984	13.10	19.17	6.06	16.58	6.67	14.29	19.63	12.90

User Ratings of Minicomputer Systems

TABLE 2. MINICOMPUTER VENDOR SUMMARIES

Burroughs	Data General	Datapoint	Digital Equipment	Four-Phase	Harris	Hewlett-Packard	Honeywell	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
27.49	27.05	50.00	33.51	16.13	42.86	31.93	36.36	Additional Software from the Manufacturer
28.65	47.54	23.53	51.72	9.68	42.86	46.99	27.27	Proprietary Software from Other Suppliers
47.95	35.25	52.94	48.55	29.03	57.14	48.80	45.45	Expansions to Data Communications Facilities
20.47	13.11	17.65	17.68	12.90	28.57	18.67	15.15	Distributed Processing Capabilities
54.39	58.20	70.59	70.98	38.71	57.14	72.89	63.64	Expansions to Present Hardware
9.36	9.02	8.82	15.83	3.23	57.14	15.06	3.03	Business Graphics
7.02	19.67	5.88	10.03	6.45	28.57	9.04	6.06	Power Conditioning Systems
								System Ratings (4.0-1.0)
3.52	3.36	3.12	3.50	3.23	3.00	3.45	3.31	Ease of Operation
3.48	3.48	3.41	3.57	3.19	2.71	3.69	3.03	Reliability of Mainframe
3.15	3.31	3.45	3.36	2.87	2.50	3.59	2.91	Reliability of Peripherals
								Maintenance Service:
3.31	3.23	3.47	3.33	3.26	3.00	3.54	3.28	Responsiveness
3.06	3.15	3.12	3.24	3.13	2.71	3.54	3.13	Effectiveness
								Technical Support:
2.70	2.75	2.79	2.95	2.94	2.71	3.17	2.71	Trouble-shooting
2.71	2.77	2.71	2.87	2.77	2.00	2.98	2.65	Education
2.45	2.65	2.53	2.96	2.58	2.00	2.90	2.65	Documentation
								Manufacturer's Software:
3.56	3.30	3.18	3.50	2.96	2.86	3.45	3.17	Operating System
3.36	3.12	3.00	3.39	2.88	2.14	3.37	3.25	Compilers & Assemblers
2.88	2.96	2.52	3.03	2.65	2.50	3.05	2.65	Applications Programs
3.30	3.28	3.06	3.27	3.09	2.43	3.26	3.03	Ease of Programming
3.21	3.01	2.94	3.02	2.45	2.50	3.11	2.80	Ease of Conversion
3.25	3.19	3.15	3.38	3.07	2.71	3.44	2.97	Overall Satisfaction
								Additional Ratings (4.0-1.0)
3.31	3.08	2.97	3.15	2.73	2.57	3.21	3.03	Ease of Reconfiguration
2.95	2.66	2.10	3.12	2.24	2.14	2.78	2.77	Compatibility of Hardware carried over from other systems
3.11	2.69	2.23	2.75	2.41	2.71	2.99	2.52	Compatibility of Programs/data carried over from other systems
2.99	3.06	3.21	2.92	2.96	2.71	3.21	3.10	Power/energy Efficiency
2.87	2.79	2.07	2.84	2.59	2.14	3.05	2.59	Productivity Aids help keep programming costs low
2.61	2.75	2.47	2.89	2.68	2.43	3.02	2.58	Software/Support promised by vendor
3.09	3.05	3.12	3.16	3.14	2.86	3.25	2.61	Keeping up with & implementing vendor changes to hardware/software (very easy=4.0; very difficult=1.0)
2.75	2.94	2.68	2.70	2.89	2.86	2.98	2.79	Delivery/Installation of equipment (ahead of schedule=4.0; very late=1.0)
2.87	2.88	2.88	2.77	2.86	2.71	2.94	2.84	Delivery of required Software (ahead of schedule=4.0; very late=1.0)
								Did the system do what you expected it to do? (%)
91.81	92.56	85.29	92.33	100.00	57.14	98.80	84.85	Yes
5.26	3.31	11.76	2.65	0.00	28.57	0.00	6.06	No
2.92	4.13	2.94	5.03	0.00	14.29	1.20	9.09	Undecided
								Would you recommend system to another user? (%)
86.55	83.47	82.35	90.74	87.10	57.14	92.12	75.00	Yes
4.68	7.44	14.71	3.70	6.45	14.29	2.42	6.25	No
8.77	9.09	2.94	5.56	6.45	28.57	5.45	18.75	Undecided

User Ratings of Minicomputer Systems
TABLE 2. MINICOMPUTER VENDOR SUMMARIES

Survey Item / Manufacturer and Model	IBM	MAI/Basic Four	MDS/Qantel	Microdata	NCR	Perkin-Elmer	Prime	Sperry
No. of User Responses	471	12	18	78	80	21	116	59
Avg. Life of System (months)	39.3	38.7	48.3	44.7	27.9	41.0	34.8	35.1
Acquisition Method (%)								
Purchase	66.95	83.33	55.56	71.79	52.50	80.95	56.90	37.29
Rental or Lease from Mfr.	14.07	16.67	16.67	5.13	30.00	4.76	28.45	52.54
Lease from 3rd Party	18.98	0.00	27.78	23.08	17.50	14.29	14.66	10.17
Principal Applications (%)								
Accounting/Billing	85.99	83.33	94.44	96.15	93.75	47.62	58.62	89.83
Banking—Check Processing/Loans/Savings	3.61	0.00	0.00	5.13	5.00	0.00	0.86	0.00
Construction/Architecture	3.40	16.67	11.11	6.41	6.25	4.76	7.76	0.00
Education—Scheduling/Administration	8.28	0.00	0.00	2.56	11.25	14.29	22.41	11.86
Engineering/Scientific	5.10	0.00	0.00	2.56	1.25	23.81	36.21	6.78
Health Care/Medical	5.94	0.00	22.22	10.26	18.75	9.52	2.59	6.78
Insurance	5.31	0.00	0.00	11.54	3.75	0.00	2.59	8.47
Manufacturing	32.27	25.00	50.00	28.21	21.25	14.29	14.66	32.20
Mathematics/Statistics	6.37	8.33	0.00	5.13	7.50	28.57	29.31	1.69
Order Processing/Inventory Control	58.81	50.00	83.33	62.82	63.75	42.86	35.34	69.49
Payroll/Personnel	67.30	58.33	77.78	61.54	78.75	9.52	47.41	72.88
Petroleum/Fuel Analysis	2.12	8.33	0.00	0.00	0.00	0.00	2.59	3.39
Process Control	4.67	8.33	0.00	2.56	8.75	14.29	2.59	1.69
Purchasing	35.88	33.33	55.56	51.28	32.50	33.33	31.03	45.76
Sales/Distribution	45.86	41.67	61.11	48.72	30.00	38.10	22.41	49.15
Other	16.56	8.33	16.67	15.38	12.50	14.29	28.45	15.25
Source of Applications Programs (%)								
In-house Personnel	81.32	91.67	27.78	65.38	66.25	80.95	84.48	93.22
"Packaged" Programs from Manufacturer	38.22	50.00	88.89	34.62	58.75	4.76	30.17	28.81
Contract Programming	36.09	33.33	50.00	47.44	37.50	33.33	19.83	23.73
Manufacturer's Personnel	1.49	8.33	22.22	1.28	3.75	0.00	0.86	8.47
Independent Suppliers	35.67	25.00	27.78	47.44	31.25	23.81	57.76	20.34
Using Data Base Management System (%)	37.69	45.45	55.56	78.67	8.00	66.67	52.63	27.12
Planning a Data Base Management System in 1984	5.99	27.27	0.00	0.00	13.33	0.00	13.16	10.17
Manufacturer's Package	100.00	0.00	0.00	100.00	0.00	100.00	56.52	100.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	43.48	0.00
Using Communications Monitor (%)	8.05	0.00	5.56	5.63	5.41	14.29	9.09	15.25
Planning a Communications Monitor in 1984	10.11	18.18	5.56	2.82	2.70	4.76	5.45	8.47
Manufacturer's Package	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Outside Vendor's Package	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Using Integrated Office Automation Functions (%)	28.38	66.67	35.29	23.94	21.92	10.00	37.27	12.28
Planning Office Automation Functions in 1984	21.05	0.00	11.76	26.76	17.81	20.00	14.55	15.79
Have a Disaster Recovery Plan (%)	51.61	25.00	72.22	55.84	57.89	33.33	48.70	52.63
Plan to in 1984	17.85	41.67	11.11	18.18	15.79	14.29	19.13	17.54

User Ratings of Minicomputer Systems

TABLE 2. MINICOMPUTER VENDOR SUMMARIES

IBM	MAI/Basic Four	MDS/Qantel	Microdata	NCR	Perkin-Elmer	Prime	Sperry	Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
23.35	25.00	66.67	26.92	32.50	38.10	26.72	28.81	Additional Software from the Manufacturer
41.83	25.00	33.33	37.18	30.00	57.14	40.52	32.20	Proprietary Software from Other Suppliers
40.98	50.00	38.89	35.90	28.75	23.81	51.72	45.76	Expansions to Data Communications Facilities
9.55	41.67	22.22	11.54	10.00	9.52	21.55	18.64	Distributed Processing Capabilities
65.18	50.00	72.22	62.82	52.50	61.90	68.10	72.88	Expansions to Present Hardware
9.13	25.00	27.78	12.82	6.25	9.52	24.14	1.69	Business Graphics
7.01	8.33	0.00	11.54	6.25	9.52	18.97	6.78	Power Conditioning Systems
								System Ratings (4.0-1.0)
3.48	3.42	3.56	3.65	3.45	2.76	3.41	3.34	Ease of Operation
3.76	3.25	3.72	3.33	3.59	3.52	3.60	3.39	Reliability of Mainframe
3.57	3.00	3.67	3.14	3.53	3.38	3.37	3.19	Reliability of Peripherals
								Maintenance Service:
3.47	3.33	3.61	3.41	3.56	3.10	3.39	3.42	Responsiveness
3.49	3.08	3.61	3.25	3.52	2.95	3.17	3.32	Effectiveness
								Technical Support:
3.04	2.75	3.11	2.92	2.95	2.67	2.70	2.80	Trouble-shooting
2.98	2.42	2.89	2.64	2.94	2.37	2.73	2.45	Education
3.02	2.00	2.71	2.65	2.71	2.43	2.60	2.44	Documentation
								Manufacturer's Software:
3.46	2.92	3.44	3.68	3.25	2.81	3.33	3.19	Operating System
3.47	2.90	3.39	3.42	3.23	2.86	3.00	3.22	Compilers & Assemblers
2.89	2.91	3.17	3.09	2.82	2.45	2.78	2.70	Applications Programs
3.44	3.50	3.31	3.56	3.36	2.85	3.25	3.17	Ease of Programming
2.89	3.00	3.53	3.29	3.16	2.94	3.19	2.78	Ease of Conversion
3.42	3.08	3.33	3.42	3.29	2.90	3.29	2.98	Overall Satisfaction
								Additional Ratings (4.0-1.0)
3.05	3.09	3.76	3.30	3.27	2.95	3.27	2.92	Ease of Reconfiguration
2.82	2.82	2.63	2.94	3.01	2.44	3.30	2.26	Compatibility of Hardware carried over from other systems
2.72	2.50	2.60	2.76	2.96	2.95	3.09	2.95	Compatibility of Programs/data carried over from other systems
3.17	3.00	3.50	2.97	3.21	2.84	3.12	3.15	Power/energy Efficiency
3.25	2.60	3.38	3.00	2.90	2.26	2.97	2.83	Productivity Aids help keep programming costs low
3.01	2.45	2.94	2.75	2.76	2.26	2.61	2.60	Software/Support promised by vendor
3.20	2.75	3.44	3.35	3.14	2.57	3.08	2.86	Keeping up with & implementing vendor changes to hardware/software (very easy = 4.0; very difficult = 1.0)
2.96	2.75	3.00	3.00	2.91	2.90	3.10	2.81	Delivery/Installation of equipment (ahead of schedule = 4.0; very late = 1.0)
2.97	2.73	2.88	2.86	2.77	2.80	3.02	2.79	Delivery of required Software (ahead of schedule = 4.0; very late = 1.0)
								Did the system do what you expected it to do? (%)
93.83	83.33	83.33	91.03	91.25	76.19	93.04	81.36	Yes
2.77	8.33	11.11	2.56	3.75	14.29	2.61	15.25	No
3.40	8.33	5.56	6.41	5.00	9.52	4.35	3.39	Undecided
								Would you recommend system to another user? (%)
94.90	75.00	88.89	91.03	86.25	61.90	91.38	76.27	Yes
2.76	16.67	5.56	5.13	5.00	23.81	3.45	10.17	No
2.34	8.33	5.56	3.85	8.75	14.29	5.17	13.56	Undecided

User Ratings of Minicomputer Systems

TABLE 2. MINICOMPUTER VENDOR SUMMARIES

Survey Item \ Manufacturer and Model	Wang	Other Minicomputers						
No. of User Responses	135	42						
Avg. Life of System (months)	35.8	54.3						
Acquisition Method (%)								
Purchase	70.15	76.19						
Rental or Lease from Mfr.	14.18	4.76						
Lease from 3rd Party	15.67	19.05						
Principal Applications (%)								
Accounting/Billing	77.78	71.43						
Banking—Check Processing/Loans/Savings	3.70	16.67						
Construction/Architecture	2.96	4.76						
Education—Scheduling/Administration	8.15	21.43						
Engineering/Scientific	6.67	16.67						
Health Care/Medical	8.15	16.67						
Insurance	5.93	9.52						
Manufacturing	20.00	26.19						
Mathematics/Statistics	5.93	14.28						
Order Processing/Inventory Control	51.85	40.47						
Payroll/Personnel	49.63	38.09						
Petroleum/Fuel Analysis	4.44	2.38						
Process Control	4.44	9.52						
Purchasing	30.37	33.33						
Sales/Distribution	35.56	40.47						
Other	22.96	23.81						
Source of Applications Programs (%)								
In-house Personnel	86.67	83.33						
"Packaged" Programs from Manufacturer	17.78	38.10						
Contract Programming	34.07	21.43						
Manufacturer's Personnel	0.74	4.76						
Independent Suppliers	43.70	30.95						
Using Data Base Management System (%)	6.77	39.02						
Planning a Data Base Management System in 1984	13.53	9.76						
Manufacturer's Package	0.00	—						
Outside Vendor's Package	100.00	—						
Using Communications Monitor (%)	8.33	12.20						
Planning a Communications Monitor in 1984	9.09	7.23						
Manufacturer's Package	0.00	—						
Outside Vendor's Package	0.00	—						
Using Integrated Office Automation Functions (%)	61.65	26.83						
Planning Office Automation Functions in 1984	13.53	14.63						
Have a Disaster Recovery Plan (%)	38.81	48.72						
Plan to in 1984	20.90	20.51						

User Ratings of Minicomputer Systems

TABLE 2. MINICOMPUTER VENDOR SUMMARIES

Wang	Other Minicomputers							Manufacturer and Model / Survey Item
								Planned Acquisitions/Implementations for 1984 (%)
31.11	40.47							Additional Software from the Manufacturer
44.44	35.71							Proprietary Software from Other Suppliers
50.37	35.71							Expansions to Data Communications Facilities
20.00	7.14							Distributed Processing Capabilities
75.56	50.00							Expansions to Present Hardware
16.30	14.28							Business Graphics
11.85	7.14							Power Conditioning Systems
								System Ratings (4.0-1.0)
3.74	3.51							Ease of Operation
3.53	3.64							Reliability of Mainframe
3.26	3.56							Reliability of Peripherals
								Maintenance Service:
3.11	3.37							Responsiveness
3.06	3.20							Effectiveness
								Technical Support:
2.63	3.26							Trouble-shooting
2.64	3.13							Education
2.55	2.85							Documentation
								Manufacturer's Software
3.26	3.45							Operating System
3.37	3.32							Compilers & Assemblers
2.98	2.90							Applications Programs
3.62	3.24							Ease of Programming
3.44	2.89							Ease of Conversion
3.34	3.39							Overall Satisfaction
								Additional Ratings (4.0-1.0)
3.54	3.03							Ease of Reconfiguration
2.21	2.90							Compatibility of Hardware carried over from other systems
2.97	2.70							Compatibility of Programs/data carried over from other systems
3.07	3.17							Power/energy Efficiency
3.38	2.68							Productivity Aids help keep programming costs low
2.61	2.95							Software/Support promised by vendor
3.02	3.10							Keeping up with & implementing vendor changes to hardware/software (very easy = 4.0; very difficult = 1.0)
2.57	3.05							Delivery/Installation of equipment (ahead of schedule = 4.0; very late = 1.0)
2.60	2.83							Delivery of required Software (ahead of schedule = 4.0; very late = 1.0)
								Did the system do what you expected it to do? (%)
92.59	92.86							Yes
2.96	4.76							No
4.44	2.38							Undecided
								Would you recommend system to another user? (%)
91.85	84.61							Yes
1.48	5.13							No
6.67	10.26							Undecided

Printed By: ZINKER_SELMA @TSII
SENT: 87-09-24 16:03
FROM: JOHNSTON_NEIL @MKT
TO: JOHNSTON_NEIL COMPETITIVE @MKT
SUBJECT: DECWorld Product Announcements

---------- TEXT ATTACHMENT ----------
SENT: 87-09-24 16:02
FROM: JOHNSTON_NEIL @MKT

DECWorld Product Announcements

Neil Johnston Competitive Analysis September 21, 1987

NOTE

The following information is accurate to the best of our knowledge at the time of publication.

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This publication describes the new product announcements at the recent DECWorld show in Boston.

Included are descriptions of:

1. MicroVAX 3000 systems
2. New peripheral devices
3. Improvements to Local-Area VAXClusters
3. DECNet Phase V
4. X.400 MAILBUS
5. Twisted-Pair Ethernet

The MicroVAX 3000
The MicroVAX 3000
The MicroVAX 3000

DEC announced two new MicroVAXes at DECWorld - the MicroVAX 3500 and the MicroVAX 3600. Slated for Q1 '88 shipment, the systems are positioned as high end departmental workstations, and were directly contrasted with the IBM 9370 product line.

Based on the same QBUS architecture as the MicroVAX II, the MicroVAX 3000s use CMOS technology, bi-level caching, and a faster clock to achieve "2.6 to 4.2 times the performance of the MicroVAX II, depending on the application", according to DEC. Although DEC did not disclose MIP ratings for the 3000s, Digital Review magazine benchmarked the system at approximately 3 MIPS.

DEC claims Office Automation performance gains for the MicroVAX 3000s, in that a MicroVAX II can support 24 simultaneous All-In-One users, and a MicroVAX 3600 is claimed to support 60 simultaneous All-In-One users. Best estimates for TPS based on performance comparisons to the MicroVAX II and the VAX 8600 is 1 to 2 TPS. Base prices are $74,800

for a MicroVAX 3500 and $99,800 for a MicroVAX 3600.

Although DEC acknowleges that there is overlap between the MicroVAX 3000s and the low-end of the VAX 8000 series - 8250 and 8350 - DEC distinguishes the two families based on Clusterability.

DEC positions the 3000s as "high end departmental workstations which are not compatible with high-end VAXClusters", and positions the 8250/8350 as "entry-level VAXBI systems which can be Clustered with larger VAXes".

A DEC OEM was quoted as saying "The 3000s are great machines for mid-sized institutions that need more performance than a MicroVAX II can provide, but don't have $300K to spend for an 8250."

As a further indication of relative performance, Neil Baldridge, VP of Development for Compu-Share, Inc in Lubbock Texas stated that his benchmarks show a MicroVAX 3600 as "three times the performance of a MicroVAX II in memory and disk intensive applications". Users at McCormick and Dodge reported that their G/L Plus General Ledger package ran 2.7 times faster on the MicroVAX 3600, and that overall throughput was 1.8 times better than a MicroVAX II.

A MicroVAX II is rated at 0.7 MIPS and 0.5 TPS, and suffers from a relatively slow CPU, a small (3 MB/Second) internal bus, and slow disks.

In the product announcement, direct price/performance comparisons were made against the 9370 product line. According to DEC, the MicroVAX 3000s have greater performance than the 9370/60, and better price/performance than the 9370/20. Most industry analysts see this as a short-term advantage, with a new 9370 model with improved price/performance rumored to be forthcoming in January.

Note that there are no technical limitations to upgrading a MicroVAX II to a MicroVAX 3500, but that "DEC has no plans to offer such an upgrade", according to a DEC source.

System Specifications

Model	MV 3500	MV 3600
CPU	CMOS	CMOS
Floating Point	Std	Std.
Ethernet controller	Std.	Std.
Backplane	QBUS	QBUS
Memory as Purchased (MB)	16	32
Max. Memory (MB)	32	32
Max. Disk (MB)	560	2488
Disk Type	(2) RA70	(3) RA70 or (1) RA82
Tape Type	TK70 cartridge	TK70 cartridge
Cabinet	21" x 27" pedastel	21" x 41" cab. (2nd cab req'd for 2 more RA82s or 1 RA82 and 1 3/4" TU81-Plus tape drive)

Operating System License for 1 - 20 users	Included	Included
Estimated MIPS	3	3
Estimated TPS	2 - 5	2 - 5
Base System Price	$74,800	$99,800

MicroVAX 3500 base system price includes 16 MB memory, 1 RA70, 1 TK70, a controller, an Ethernet connection, and the Operating System.

MicroVAX 3600 base system price includes 32 MB memory, 1 RA82, 1 TK70, a controller, an Ethernet connection, and the Operating System. The second cabinet with two peripherals included brings the total base system price for the MicroVAX 3600 to $180,000.

MicroVAX 3000 Analysis

All of the success of the MicroVAX II can be attributed to price/performance, and DEC's considerable momentum in the VAX/VMS applications world.

The MicroVAX 3000 series has significantly improved price/performance, and will extend sales of the MicroVAX product line into larger business environments. The MicroVAX 3000 also makes the Local-Area VAXCluster a significantly stronger product for distributed systems, in terms of both enhanced functionality and improved price/performance.

However, in terms of On Line Transaction Processing environments, the weakness of the MicroVAX is still:

- its monolithic architecture
- its relatively weak I/O subsystem (DEC disks and channels do not set industry standards in either performance or reliability)
- its lack of transaction-processing software, and
- the lack of mirrored disks, which are not supported on any of the MicroVAX configurations.

The VMS Operating System has no Transaction Monitoring or Protection facilities. There is no ability to protect transactions in process, and no ability to protect transactions between backups. Some Third Party applications solutions implement their own versions of "TMF", but in most cases transaction protection is applied only to data stored in a Relational Database.

In addition, DEC does not have a truly distributed database. The best they can do is replication and extraction, with satellite nodes either having their own copy of the master database and applying updates to their own copy, or all satellites pushing updates across the network to the master, which is very overhead-intensive.

Oracle corporation makes marketing claims to have a distributed database; however, they cannot do distributed updates.

In most applications, a MicroVAX is a typical stand-alone, monolithic processor with many single points of failure and an operating system that offers no transaction processing or transaction protection functionality.

OLTP Comparison Chart

Fault Tolerance	The MicroVAX does not have a fault-tolerant architecture. MicroVAXes can be Clustered together but with measurable overhead and poor Cluster-wide recovery times (See: "The VAXCluster -- How to Beat It" on SIRS).
Data Integrity	The VMS Operating System has no Transaction Protection or Monitoring facilities.
Modular/ Linear Growth	Unavailable due to software overhead in Networks and Clusters. NOTE THAT MICROVAX IIS CANNOT BE UPGRADED TO MICROVAX 3000S.
Networking	MicroVAXes support DEC's implementation of Ethernet.
	Ethernet as supplied by DEC is not fault-tolerant, and offers no more than 3 to 4 megabits/second of throughput at peak. Ethernet offers extensive connectability, and sophisticated management tools.
Distributed Data Processing	DEC can distribute MicroVAXes for processing, but has no Distributed Database capabilities. Each MicroVAX node has its own separate database.
Ease of Use	End users rank DEC highly in this category.

New Peripherals
New Peripherals
New Peripherals

RA70

The RA70 is Digital's first 5 1/4 " Winchester disk, designed specifically for the MicroVAX 3000s and currently available only with the MicroVAX 3000.

RA82

A "4-pack" SA482 configuration (4 RA82s in one cabinet) was released as a bundled system for high-end VAXClusters earlier this year. Now the RA82 has been unbundled as individual disk units which are currently available for use with all VAX and MicroVAX systems.

RA82s are available installed in a MicroVAX 3000 cabinet, in which case the price is bundled in with the system price; or in "3-pack" cabinets for larger VAXes. RA82s are still not being sold as add-on "quantity one" orders.

Disk Specifications

Model	RA70	RA82
Form Factor	5 1/4"	19"
Formatted Capacity	280 MB	622 MB
Average Seek	19.5 msecs	24 msecs
Rotational Latency	7.5 msecs	8 msecs
Average Access	27 msecs	32 msecs
Data Transfer Rate	1.4 MB/sec	2.2 MB/sec

One Year Warranty	Included	Included
Price	$9,000	$65,500 (for three)

TK70

The TK70 is a 5 1/4", 296 MB streaming-tape cartridge drive, with a maximum data transfer rate of 90KB/second, and priced at $7,300.

Improvements to Local-Area VAXClusters
Improvements to Local-Area VAXClusters
Improvements to Local-Area VAXClusters

Local-Area VAXClusters (LAVCs) are groups of up to 15 MicroVAXes linked together with Ethernet and operating as a "low-end" VAXCluster. (see: The VAXCluster - How to Beat It, located on SIRS).

Local-Area VAXClusters are considered better than DECNet implementations in providing better functionality for work groups which require distributed processing AND sharing of resources (disks, tapes, printers, software) and is considered easier to manage than a DECNet network.

The problem to date with Local-Area VAXClusters has been price/performance. Each Local-Area VAXCluster has been dependent upon the speed of the central "boot member" which handles the startup and operations of the whole Cluster.

Cost-effective LAVCs have used MicroVAX IIs as "boot members", as well as MicroVAX IIs as distributed "satellite" nodes. The problem has been performance. A LAVC can keep a MicroVAX II boot member so busy that it can't handle any "host based" functionality, requiring each satellite to be self-sufficient for applications, and requiring a large amount of network traffic for shared applications, with corresponding high amounts of overhead.

Performance-oriented LAVCs have used 8200/8250 machines as boot members, which have provided enough horsepower to run the LAVC as well as handle a minimum of centralized applications, but at significantly higher costs.

DEC is now touting the MicroVAX 3000s as ideal boot members. The MicroVAX 3600 in particular has enough power to run the LAVC as well as act as a central server for common applications, leaving the MicroVAX II satellites free to concentrate on localized applications.

LAVCs with MicroVAX 3000s are a potent combination for

small-to-medium-sized organizations requiring distributed processing.

DECNet Phase V
DECNet Phase V
DECNet Phase V

The birth of DECNet Phase V Architecture was announced at DECWorld. Details were sketchy: the announcment was viewed by most analysts as lacking in concreteness, and as being mostly promises and statements of direction. DECNet Phase V product changes will be implemented over a three-year period.

Analysts were generally disappointed with the announcement. They had been expecting DEC to announce a new SNA gateway, and new Network Management software to counter IBM's Netview announcement.

A major focus for DECNet Phase V is full compliance with the OSI model by 1990. DECNet Phase V itself will, over three years, become compatible with the first four OSI layers.

DEC hopes to be the first vendor to market a full OSI-compatible implementation of its network. Their stated goal is to adhere to OSI in order to become the vendor of choice for implementations of multi-vendor backbone networks.

As a general statement of future direction, DEC disclosed plans to increase connectivity at the desktop, increase their ability to connect heterogenous hardware while maintaining interoperability, to further enhance network management products, and to increase their capabilities to distribute information throughout the network.

X.400 MAILBUS
X.400 MAILBUS
X.400 MAILBUS

A major feature of DECNet Phase V was the announcement of the "MAILBUS" product. MAILBUS is a software package that provides a fully X.400-compliant bridge between different IBM environments. MAILBUS currently allows DISOSS, SNADS, and All-In-One users to send data, documents, and MS/DOS files to each other. The system has full support for "store and forward" message sending, logging, and error correction.

Analysts expressed disappointment that support for DISOSS was chosen over support for PROFS. DEC has plans for an eventual EMAIL bridge to PROFS, as well as to other X.400-compliant systems, but the PROFS link has been long-awaited.

Unshielded Twisted Pair Ethernet Adapter (UTPEA)
Unshielded Twisted Pair Ethernet Adapter (UTPEA)
Unshielded Twisted Pair Ethernet Adapter (UTPEA)

DEC announced that a one year development effort with 3COM has resulted in release of a product that both companies will market: the migration of Ethernet to unshielded single-twisted-pair telephone lines.

This product is the first of its kind on the market (although Sun Optics and Hewlett-Packard are expected to release their own versions shortly), and will make it easier for customers who have already installed twisted-pair wire in their buildings to convert to Ethernet without recabling. The product is said to markedly decrease the cost-per-node for network connections, while supporting the full 10 mbits/second Ethernet bandwidth.

If the product is successful, most analysts expect DEC to take a close look at supporting 3COM's version of Token Ring networks in addition to supporting Ethernet.

DECWorld Impressions
DECWorld Impressions
DECWorld Impressions

DECWorld as a whole was an impressive show. Crowds were heavy, but DEC had approximately 10,000 employees there to help. Although the logistics of the show were a bit confusing at times, the individual sessions (which were "high-level" overviews designed for CEOs and CFOs) were very well done and professionally presented.

The theme for DECWorld was "The Network at Work". There was a large display area of DEC systems and products, which was connected into DEC's worldwide corporate network (claimed to be the largest in the world, with over 20,000 systems operating to date). DEC moved their Network Control Center to the DECWorld site to show "real live" Network Managment at work.

There was a strong focus on both Industry Marketing and Third Parties. General sessions were presented on DEC and DEC products, but the majority of the sessions were arranged by industry. In the display area, DEC systems and products were displayed side-by-side with Third-party products, in a strong show of teamwork. Nearly 200 DEC Third-party suppliers were in attendance at the show.

DEC captured large amounts of attention from the industry. Some analysts "pooh-poohed" the show, saying that IBM has quietly been putting on shows like this for years. However, DEC received front-page publicity in a large number of publications, and Computerworld did a special "Computerworld Extra" insert devoted entirely to DEC.

If you have any questions about DECWorld, or about the new product announcements, please contact Neil Johnston at (408) 725-7404 or johnston_neil on PSMAIL.

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Research

Tandem Computers Inc.*

TNDM-OTC-BUY

Peter Labé, C.F.A.

Outlook Improving

January 4, 1985

Price	52-Week Range	Earnings Per Share** 1984	1985E	1986E	P/E Ratio 1985E	1986E	Yield	Return on Equity
$18	$40-13	$0.80	$1.25	$1.75	14.4	10.2	None	9.7%

* Drexel Burnham Lambert Incorporated makes a market in this security.
** Fiscal year ends September 30th.

POINT OF VIEW

Tandem, the world's largest vendor of fault-tolerant systems optimized for transaction processing, was a disappointing stock in early 1980s due to a combination of too-high valuation and not enough growth, and more recently, due to erratic operating performance. The stock, now half its high last year, appears to us to have overreacted. We believe the following:

1. The potential market is large and growing, with very limited direct competition.
2. The company has greatly improved its product line and competitiveness.
3. Drastic improvement is in evidence in financial controls, and more recently, in cost control.
4. Investors appear to have given up on a 30% growth rate, and could be surprised over the next few years.
5. We recommend purchase of Tandem stock for intermediate-term investors who can withstand above average volatility.

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Background

In the fiscal year ended September 30, 1984, Tandem had revenues of $533 million, divided 84% equipment sales, and 16% service and other. The company announced its first computer system product, the NonStop I, in 1975, after having been founded in 1974 by a group that previously had been associated with Hewlett-Packard Corporation. The company became publicly-owned in December 1977 and through fiscal 1981 reported spectacular growth, practically doubling every year. Operating margins in the 16%-20% range were customarily reported, reflecting the relatively proprietary nature of the company's product and strong acceptance by users.

Since then, a variety of problems overtook the company. Apparently encouraged by early success, the company expanded too rapidly and even today has significant overcapacity. Far too much of the business was done in the closing weeks of a quarter, with tremendous pressure on orders and shipments. Inventories and receivables typically were high, and the company consumed cash. The turnover of executives accelerated, and overall personnel turnover increased. Revenue growth slowed to 50%, then 34% and last year, 27%. Margins declined, and earnings flattened.

One result has been virtually no earnings growth for the last three consecutive fiscal years. Perhaps more than any other single event though, the unexpectedly disastrous March quarter a year ago hurt investors. In the December quarter, Tandem had earned $0.24 per share and in October introduced a hot new product, the TXP, and most investors expected that the following quarter would be sequentially up--not the $0.05 per share that was reported. The explanation that the company was seeing "mainframe" seasonal-type spending patterns by users didn't sit that well with investors, who were unprepared. Not only were estimates marked down, but longer-term growth rate assumptions were reexamined and reduced. From a peak of $40 1/4, the stock was marked down to a low of 13.

Tandem still doesn't operate with any backlog to speak of, but then neither does anyone else in the industry these days. However, there are reasons to expect stronger performance, without any guarantees everything will be smooth. If we look at today versus five years ago, it may be more apparent.

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	5 Years Ago	Today
Processors	One product: NonStop I	Three products: NonStop I Nonstop II TXP
Disk	Ampex/CDC Conventional drives	Fujitsu high reliability drives plus standard drives
Terminals	any	any plus self-manufacture Tandem 65XX line, incl. recent "Dynamite" with IBM-PC compatibility
Software	operating system	operating system high level languages report writers networking SNA compatibility distrubuted data base
Inventories	high	low
Receivables	fair	good
Cash	poor	outstanding
User perception	product aging	product leadership
User awareness	growing	established
Strategy	sell/sell/sell	market

In short, we think we see a very different company today, one that is more disciplined and more controlled and one that understands not only the opportunities but also the problems.

So much for a thumbnail background. We turn next to the opportunities, and the risks as well.

Opportunities

Tandem's computer architecture has some peculiar features. It is optimized for rapid processing of "transactions," which are typically described in a limited number of data fields with relatively streamlined instruction sets; Tandem primarily uses 16-bit wordlength though its more recent products have 32-bit internal structure. This is not a drawback in this market, and in fact most studies conclude Tandem

has a performance advantage over other equipment in these types of applications. Tandem also has parallel processors connected by a high-speed bus to checkpoint back and forth, so that a high degree of fault tolerance is achieved; moreover, this duality is carried through to disk controllers and disk. While this is a catchy idea, it is not really worth much in today's environment, but nevertheless handy to have. Data processing managers do, however, love the high degree of data integrity that Tandem systems provide. And, the painless and easy modular expansion -- truly linear -- up to 16 processors is very advantageous.

On top of this still-unchallenged architecture, Tandem over the years has developed as broad a range of operating system software and utility programs as most people might want. A typical Tandem sale in the old days was a pair of processors to a user, who would then spend 9-12 months developing his application, and then purchase more units the following year to implement his application and continue to grow over time. The modularity of the product got around the argument that Tandem was a one-product company.

The difficulty that Tandem eventually ran into was several fold:

1. Competition, even with vastly less sophisticated solutions, improved their transaction performance.

2. Users, partly unsold by competitors, became less willing to devote enough programmer support to do the applications unless the case was overwhelming.

3. High-performance products carried a higher initial sale price and a higher ultimate commitment, leaving a void at the bottom.

Tandem's response was to offer a leadership product (TXP) and regain image with users, and broaden the product line with lower level entry points. Anywhere in the computer business, getting installed is always a step in selling more to an account. Ancillary product support in the peripherals was stepped up. And, most of all, the company finally began to strongly encourage third-party software support. This is the key to the 1980s in the industry since the more applications that can be written on Tandem, the greater the potential market. A single application can be ported to a large number of users rather than one of a kind, and the user is much more easily sold if a "canned" package is readily observable and referenceable.

The computer world has been moving from "batch" to "on-line" for more than a decade. Studies suggest that we have moved from maybe 10%

on-line to 60-70% today. What portion of this is "transaction" oriented is anybody's guess, but it is clearly a multi-billion dollar market. We do not consider Tandem at its present size in any way limited by size of market.

Problems

We have already alluded to the principal problem. Most every entity has a computer today. The installed vendor is always going to resist any intrusion, and fight for any new application. This is true even though in every case involving transactions Tandem has a better solution. The only two companies really worth worrying about are IBM and DEC; it is quite clear that neither is going to confront Tandem head-on in a product sense. In fact, in IBM's case, transaction processing is the weakest part of IBM software. Moreover, IBM has serious architectural restraints.

To deal with this problem, Tandem has to change from a sales company to a marketing company. There are signs this is underway. In addition, Tandem needs to become a software purveyor, not just hardware. There are signs this too is underway. If we are correct in our assessment, Tandem could grow 30% a year for the next few years, which would be an upside surprise for investors.

Recent Developement

Tandem has revamped its product pricing in recent months, by (1) raising the price of the high-end TXP processor 4%; (2) reducing old low-end NonStop I prices from 12% to 45% (these have been out of new production for years but a number of low-end systems are in inventory); (3) reducing prices 24% on the mid-range NonStop II; and (4) establishing a trade-in program to enable customers to get TXP processors in exchange for NonStop I and II processors at credits ranging from 60% to 80% of their list price.

The goal is to lower the entry price to get into the Tandem product line, and relieve user anxiety over selecting the wrong system for this need since he can always trade up.

We are very bullish on these changes. Moreover, over the next 12 months, we expect the following:

1. New additions to system software, particularly in disk handling.

2. A new-low end system (code named "Checkmate") -- probably for January or February introduction.

3. A continuing stream of third-party software agreements and announcements.

4. No adverse surprises in the numbers.

The latter is of more than passing interest. The quarterly earnings risks began with the September quarter, already reported, and which came out above investor expectations. (See Volume I, Issue 1 of "Computer Talk," P. 14 discussing the quarter's 30% revenue gain and 38% earnings gain.) We attribute this to the TXP trade-in program. The December quarter also poses some risks, but we believe earnings will be at least flat with the September quarter and roughly 25% up from last year. While there is a risk revenues could be a little light, we do not believe investors will be disappointed by earnings. The real key is the upcoming March quarter. This is the quarter Tandem fell down last year. Our expectation is that earnings will be flat with the December quarter - some six times those of a year ago and an upside surprise. If Tandem can do this, investor confidence in estimates should increase dramatically and with it, we believe, renew expectations of rapid growth.

Finance

Few areas of operations are as clear as finance. At the end of fiscal 1982, Tandem's inventory of $101.3 million was 93% of 1982's cost of revenues. Receivables were more than 36% of revenues. Cash of $24.8 million was 9% of revenues. At the end of fiscal 1984, by contrast, inventories were 42% of cost of revenues, receivables were 27% of revenues, and cash of $106.9 million was 20% of revenues. Tandem was then, and is now, essentially debt-free.

Previously, revenue recognition was typically made on anything that moved off the loading dock at the end of the quarter regardless of when it was to be installed. Now, revenue is recognized only on equipment that is installed within 15 days of shipment domestically or 30 days internationally, the most conservative policy in the industry. Operating margins, 17.7% and 19.4% in fiscal 1980 and 1981, respectively, had declined to 9.6% in fiscal 1984. We believe these can recover to 12.5% or more in fiscal 1985, and over 14% in fiscal 1986. Combined with revenue growth, the earnings dynamics become exceptional. In fiscal 1985, we believe EPS can fall in a range of $1.25 to $1.35, and in fiscal 1986, from $1.75 to $1.85. Calendarizing these numbers gets to $1.40 or so in 1985, and approaching $2.00 in calendar 1986. By our calculations, 30% revenue growth in 1985

would not draw down cash very greatly -- improving margins should increase profitability and there are low capital spending needs with an overcapacity situation.

Part of the improved profitability comes with volume and a higher portion of new high-margin products in the mix; part comes from a hiring freeze (except sales) and reexamination and cost control of the overhead accounts. The emphasis on profitability and asset management are (in broad terms) something new at Tandem.

The balance sheet is, in a word, powerful. Summary data is shown in a table in the appendix. Also attached in the appendix are (1) our "optimistic" model for Tandem's quarterly earnings, not our official or more conservative numbers, and (2) a brief financial summary.

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Prices of securities mentioned in this report:

Hewlett-Packlard Company - HWP (NYSE-34)
International Business Machines Corporation - IBM (NYSE-121)
Digital Equipment Corporation - DEC (NYSE-109)

APPENDIX:

Table i - Balance Sheet Data

Table ii - Quarterly Model

Table iii - Financial Summary

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Table i
Tandem Computers Inc.
Balance Sheet Data
($ in millions)

	9/30/84	9/30/83
Cash & Equivalents	$106.9	$ 93.5
Accounts Receivable	146.3	119.6
Inventories	92.4	85.9
Prepaid Expenses	7.0	11.8
Total Current Asset	$352.6	$310.8
Short-term Debt	$ 15.0	$ 3.3
Other Current Liabilities	74.1	53.3
Total Current Liabilities	$ 89.2	$ 56.6
Net Working Capital	$263.4	$254.2
Gross Plant, Property and Equipment	191.7	132.8
Accum. Depreciation	50.3	34.0
Net Plant	$141.4	$ 98.8
Other Assets	7.8	6.0
Total Net Assets	$412.6	$359.0
Long-term Debt	5.4	8.5
Capitalized Leases	11.7	15.5
Deferred Taxes	20.4	24.0
Shareholders' Equity	375.1	311.0
Total Net Capital	$412.6	$359.0

Table ii

TANDEM COMPUTERS INC.

(Data in $000)
Years to 9/30

	Actual 1Q84 12/31/83	Actual 2Q84 3/31/84	Actual 3Q84 6/30/84	Actual 4Q84 9/30/84	Actual Year 84 9/30/84	Estimate 1Q85 12/31/84	Estimate 2Q85 3/31/85	Estimate 3Q85 6/30/85	Estimate 4Q85 9/30/85	Estimate Year 85 9/30/85	Estimate 1Q86 12/31/85	Estimate Year 86 9/30/86
Product Revenue	$108,474	$91,223	$119,064	$129,850	$448,611	$137,500	$144,000	$155,000	$166,000	$602,500	$172,000	$780,000
Service & Other	17,895	20,012	22,861	23,240	84,009	24,000	25,000	26,500	26,500	103,000	284,00	120,000
Total Revenue	126,369	111,236	141,925	153,090	532,620	161,500	169,000	181,500	193,500	705,500	200,400	900,000
Cost of Revenue	50,437	47,245	57,787	63,341	218,810	66,538	69,628	72,963	75,852	284,981	78,356.4	348,300
% of Revenue	39.9%	42.5%	40.7%	41.4%	41.1%	41.2%	41.2%	40.2%	39.2%	40.4%	39.1%	38.7%
R&D	10,849	12,853	13,514	15,298	52,514	15,989	16,900	17,787	18,963	69,639	20,040	90,000
% of Revenue	8.6%	11.6%	9.5%	10.0%	9.9%	9.9%	10.0%	9.8%	9.8%	9.9%	10.0%	10.0%
SG&A	48,205	49,032	56,282	56,576	210,195	59,755	63,375	67,155	71,595	261,880	74,148	333,000
% of Revenue	38.1%	44.2%	39.7%	37.0%	39.5%	37.0%	37.5%	37.0%	37.0%	37.1%	37.0%	37.0%
Operating Costs	109,491	109,230	127,583	135,215	481,519	142,281.5	149,903	157,905	166,410	616,499.5	172,544.4	771,300
Operating Profit	16,878	2,006	14,342	17,875	51,101	19,218.5	19,097	23,595	27,090	89,000.5	27,855.6	128,700
Oper. Profit Margin	13.4%	1.8%	10.1%	11.7%	9.6%	11.9%	11.3%	13.0%	14.0%	12.6%	13.9%	14.3%
Other Income, Net	1,076	1,142	1,243	1,722	5,183	1,630	1,590	1,400	1,300	5,920	1,200	4,600
Pretax Income	17,954	3,148	15,585	19,597	56,284	20,848.5	20,687	24,995	28,390	94,920.5	29,055.6	133,300
Pretax Margin	14.2%	2.8%	11.0%	12.8%	10.6%	12.9%	12.2%	13.8%	14.7%	13.5%	14.5%	14.8%
Income Taxes	7,900	1,174	6,335	7,667	23,076	8,443.6	8,378.2	10,123.0	11,498.0	38,442.8	11767.5	53,986.5
Tax Rate	44.0%	37.3%	40.6%	39.1%	41.0%	40.5%	40.5%	40.5%	40.5%	40.5%	40.5%	40.5%
Net Rate	10,054	1,974	9,250	11,930	33,208	12,404.9	12,308.8	14,872.0	16,892.1	56,477.7	17,288.1	79,313.5
Avg. Shares (000)	41,841	41,794	41,039	40,923	41,399	41,100	41,200	41,400	41,600	41,325	41,750	42,700
E.P.S.	$0.24	$0.05	$023	$0.29	$0.80	$0.30	$0.30	$0.36	$0.41	$1.37*	$0.41	$1.86*

*This is our "optimistic" model, our official estimates are $1.25 in fiscal 1985 and $1.75 in fiscal 1986.

Table iii
Tandem Computers Inc.
Financial Summary

Years to 9/30	Revenues ($000)	Pretax Income ($000)	Pretax Profit Margin	Effective Tax Rate	Net Income ($000)	% Return on Yearend Equity	Per Share Data (a) EPS	Div	Stock Price Range(b)	P/E Range(b)
1984	$532,620	$56,284	10.6%	41.0%	$33,208	8.8%	$0.80	--	40-13	50-16
1983	412,282	50,501	12.2	39.0	30,805	9.9	0.76	--	40-24	53-32
1982R	312,143	46,741	15.0	36.1	29,856	11.9	0.76	--	33-14	43-19
1981	208,397	51,098	24.5	48.0	26,549	13.0	0.72	--	35-20	48-28
1980	108,989	21,082	19.3	49.3	10,687	15.2	0.35	--	33-14	43-19
1979	55,974	10,104	18.1	51.3	4,920	15.6	0.20	--	7-4	32-19
1978	24,305	4,490	18.5	52.0	2,153	13.9	0.10	--	6-2	60-22
1977	7,692	329	4.3	52.0	158	5.8	0.01	--	3-2(c)	N.C.
1976	581	(2,169)	Def.	--	(2,169)	Def.	(0.72)	--	--	--
1975	--	(646)	Def.	--	(646)	Def.	(0.25)	--	--	--

Notes: (a) Adjusted for stock splits
(b) Calendar year for stock prices; P/E based on fiscal year earnings and calendar year prices
(c) Range since initial public offering 12/14/77
R Restated

Source: Standard investment manuals

February 4, 1985

Tandem Computers Inc. - Company Report
DREXEL BURNHAM LAMBERT INCORPORATED - Labe, P.
01-04-85 (RN=500586)

Tandem Computers Inc. (*)
TNDM - OTC - BUY

Outlook Improving

Price	52-Week Range	Earnings Per Share (**) 1984	1985E	1986E	P/E Ratio 1985E	1986E
$18	$40.13	$0.80	$1.25	$1.75	14.4	10.2

Yield	Return on Equity
None	9.7%

(*) Drexel Burnham Lambert Incorporated makes a market in this security.
(**) Fiscal year ends September 30th.

POINT OF VIEW

Tandem, the world's largest vendor of fault-tolerant systems optimized for transaction processing, was a disappointing stock in early 1980s due to a combination of too-high valuation and not enough growth, and more recently, due to erratic operating performance. The stock, now half its high last year, appears to us to have overreacted. We believe the following:

(1) The potential market is large and growing, with very limited direct competition.

(2) The company has greatly improved its product line and competitiveness.

(3) Drastic improvement is in evidence in financial controls, and more recently, in cost control.

(4) Investors appear to have given up on a 30% growth rate, and could be surprised over the next few years.

(5) We recommend purchase of Tandem stock for intermediate-term investors who can withstand above average volatility.

BACKGROUND

In the fiscal year ended September 30, 1984, Tandem had revenues of $533 million, divided 84% equipment sales, and 16% service and other. The company announced its first computer system product, the NonStop I, in 1975, after having been founded in 1974 by a group that previously had been associated with Hewlett-Packard Corporation. The company became publicly-owned in December 1977 and through fiscal 1981 reported spectacular growth, practically doubling every year. Operating margins in the 16%-20% range were customarily reported, reflecting the relatively proprietary nature of the company's product and strong acceptance by users.

Since then, a variety of problems overtook the company. Apparently encouraged by early success, the company expanded too rapidly and even today has significant overcapacity. Far too much of the business was done in the closing weeks of a quarter, with tremendous pressure on orders and shipments. Inventories and receivables typically were high, and the company consumed cash. The turnover of executives accelerated, and overall personnel turnover increased. Revenue growth slowed to 50%, then 34% and last year, 27%. Margins declined, and earnings flattened.

One result has been virtually no earnings growth for the last three consecutive fiscal years. Perhaps more than any other single event though, the unexpectedly disastrous March quarter a year ago hurt investors. In the December quarter, Tandem had earned $0.24 per share and in October introduced a hot new product, the TXP, and most investors expected that the following quarter would be sequentially up -- not the $0.05 per share that was reported. The explanation that the company was seeing "mainframe" seasonal-type spending patterns by users didn't sit that well with investors, who were unprepared. Not only were estimates marked down, but longer-term growth rate assumptions were reexamined and reduced. From a peak of $40 1/4, the stock was marked down to a low of 13.

Tandem still doesn't operate with any backlog to speak of, but then neither does anyone else in the industry these days. However, there are reasons to expect stronger performance, without any guarantees everything will be smooth. If we look at today versus five years ago, it may be more apparent.

	5 Years Ago	Today
Processors	One Product: Nonstop I	Three products: NonStop I Nonstop II TXP
Disk	Ampex/CDC Conventional drives	Fujitsu high reliability drives plus standard drives
Terminals	any	any plus self-manufacture Tandem 65xx line, incl. recent "Dynamite" with IBM-PC compatibility
Software	operating system	operating system high level languages report writers networking SNA compatibility distributed data base
Inventories	high	low
Receivables	fair	good
Cash	poor	outstanding
User perception	product aging	product leadership
User awareness	growing	established
Strategy	sell/sell/sell	market

In short, we think we see a very different company today, one that is more disciplined and more controlled and one that understands not only the opportunities but also the problems.

So much for a thumbnail background. We turn next to the opportunities, and the risks as well.

Opportunities

Tandem's computer architecture has some peculiar features. It is optimized for rapid processing of "transactions," which are typically described in a limited number of data fields with relatively streamlined instruction sets; Tandem primarily uses 16-bit worldlength though its more recent products have 32-bit internal structure. This is not a drawback in this market, and in fact most studies conclude Tandem has a performance advantage over other equipment in these types of applications. Tandem also has parallel processors connected by a high-speed bus to checkpoint back and forth, so that a high degree of fault tolerance is achieved; moreover, this duality is carried through to disk controllers and disk. While this is a catchy idea, it is not really worth much in today's environment, but nonetheless handy to have. Data processing managers do, however, love the high degree of data integrity that Tandem systems provide. And, the painless and easy modular expansion -- truly linear -- up to 16 processors is very advantageous.

On top of this still-unchallenged architecture, Tandem over the years has developed as broad a range of operating system software and utility programs as most people might want. A typical Tandem sale in the old days was a pair of processors to a user, who would then spend 9-12 months developing his application, and then purchase more units the following year to implement his application and continue to grow over time. The modularity of the product got around the argument that Tandem was a one-product company.

The difficulty that Tandem eventually ran into was several fold:

1. Competition, even with vastly less sophisticated solutions, improved their transaction performance.

2. Users, partly unsold by competitors, became less willing to devote enough programmer support to do the applications unless the case was overwhelming.

3. High-performance products carried a higher initial sale price and a higher ultimate commitment, leaving a void at the bottom.

Tandem's response was to offer a leadership product (TXP) and regain image with users, and broaden the product line with lower level entry points. Anywhere in the computer business, getting installed is always a step in selling more to an account. Ancillary product support in the peripherals was stepped up. And, most of all, the company finally began to strongly encourage third-party software support. This is the key to the 1980s in the industry since the more applications

that can be written on Tandem, the greater the potential market. A single application can be ported to a large number of users rather than one of a kind, and the user is much more easily sold if a "canned" packaged is readily observable and referenceable.

The computer world has been moving from "batch" to "on-line" for more than a decade. Studies suggest that we have moved from maybe 10% on-line to 60-70% today. What portion of this is "transaction" oriented is anybody's guess, but it is clearly a multi-billion dollar market. We do not consider Tandem at its present size in any way limited by size of market.

Problems

We have already alluded to the principal problem. Most every entity has a computer today. The installed vendor is always going to resist any intrusion, and fight for any new applications. This is true even though in every case involving transactions Tandem has a better solution. The only two companies really worth worrying about are IBM and DEC; it is quite clear that neither is going to confront Tandem head-on in a product sense. In fact, in IBM's case, transaction processing is the weakest part of IBM software. Moreover, IBM has serious architectural restraints.

To deal with this problem, Tandem has to change from a sales company to a marketing company. There are signs this is underway. In addition, Tandem needs to become a software purveyor, not just hardware. There are signs this too is underway. If we are correct in our assessment, Tandem could grow 30% a year for the next few years, which would be an upside surprise for investors.

INVESTEXT/DATA PROCESSING
February 4, 1985

Tandem Computers Inc. - Company Report
(continued)

Recent Development

Tandem has revamped its product pricing in recent months, by (1) raising the price of the high-end TXP processor 4%; (2) reducing old low-end NonStop I prices from 12% to 45% (these have been out of new production for years but a number of low-end systems are in inventory); (3) reducing prices 24% on the mid-range NonStop II; and (4) establishing a trade-in program to enable customers to get TXP processors in exchange for NonStop I and II processors at credits ranging from 60% of their list price.

The goal is to lower the entry price to get into the Tandem product line, and relieve user anxiety over selecting the wrong system for this need since he can always trade up.

We are very bullish on these changes. Moreover, over the next 12 months, we expect the following:

1. New additions to system software, particularly in disk handling.

2. A new-low end system (code named "Checkmate") -- probably for January or February introduction.

3. A continuing stream of third-party software agreements and announcements.

4. No adverse surprises in the numbers

The latter is of more than passing interest. The quarterly earnings risks began with the September quarter, already reported, and which came out above investor expectations. (See Volume I, Issue 1 of "Computer Talk," P.14 discussing the quarter's 30% revenue gain and 38% earnings gain.) We attribute this to the TXP trade-in program. The December quarter also poses some risks, but we believe earnings will be at least flat with the September quarter and roughly 25% up from last year. While there is a risk revenues could be a little light, we do not believe investors will be disappointed by earnings. The real key is the upcoming March quarter. This is the quarter Tandem fell down last year. Our expectation is that earnings will be flat with the December quarter - some six times those of a year ago and an upside surprise. If Tandem can do this, investor confidence in estimates should increase dramatically and with it, we believe, renew expectations of rapid growth.

Finance

Few areas of operations are as clear as finance. At the end of fiscal 1982, Tandem's inventory of $101.3 million was 93% of 1982's cost of revenues. Receivables were more than 36% of revenues. Cash of $24.8 million was 9% of revenues. At the end of fiscal 1984, by contrast, inventories were 42% of cost of revenues, receivables were 27% of revenues, and cash of $106.9 million was 20% of revenues. Tandem was then, and is now, essentially debt-free.

Previously, revenue recognition was typically made on anything that moved off the loading dock at the end of the quarter regardless of when it was to be installed. Now, revenue is recognized only on equipment that is installed within 15 days of shipment domestically or 30 days internationally, the most conservative policy in the industry. Operating margins, 17.7% and 19.4% in fiscal 1980 and 1981, respectively, had declined to 9.6% in fiscal 1984. We believe these can recover to 12.5% or more in fiscal 1985, and over 14% in fiscal 1986. Combined with revenue growth, the earnings dynamics become exceptional. In fiscal 1985, we believe EPS can fall in a range of $1.25 to $1.35, and in fiscal 1986, from $1.75 to $1.85. Calendarizing these numbers gets to $1.40 or so in 1985, and approaching $2.00 in calendar 1986. By our calculations, 30% revenue growth in 1985 would not draw down cash very greatly -- improving margins should increase profitability and there are low capital spending needs with an overcapacity situation.

Part of the improved profitability comes with volume and a higher portion of new high-margin products in the mix; part comes from a hiring freeze (except sales) and reexamination and cost control of the overhead accounts. The emphasis on profitability and asset management are (in broad terms) something new at Tandem.

The balance sheet is, in a word, powerful. Summary data is shown in a table in the appendix. Also attached in the appendix are (1) our "optimistic" model for Tandem's quarterly earnings, not our official or more conservative numbers, and (2) a brief financial summary.

Prices of securities mentioned in this report:

Hewlett-Packard Company - HWP (NYSE-34)
International Business Machines Corporation - IBM (NYSE-121)
Digital Equipment Corporation - DEC (NYSE-109)

Table i
Tandem Computers Inc.
Balance Sheet Data
($ in millions)

	9/30/84	9/30/83
Cash & Equivalents	$106.9	$93.5
Accounts Receivable	146.3	119.6
Inventories	92.4	85.9
Prepaid Expenses	7.0	11.8
Total Current Asset	$352.6	$310.8
Short-term Debt	$15.0	$3.3
Other Current Liabilities	74.1	53.3
Total Current Liabilities	$89.2	$56.6
Net Working Capital	$263.4	$254.2
Gross Plant, Property and Equipment	191.7	132.8
Accum. Depreciation	50.3	34.0
Net Plant	$141.4	$98.8
Other Assets	7.8	6.0
Total Net Assets	$412.6	$359.0
Long-term Debt	5.4	8.5
Capitalized Leases	11.7	15.5
Deferred Taxes	20.4	24.0
Shareholders' Equity	375.1	311.0
Total Net Capital	$412.6	$359.0

Table ii

TANDEM COMPUTERS INC.

(Data in $000)
Years to 9/30

[Part 1 of 3]

	Actual 1Q84 12/31/83	Actual 2Q84 3/31/84	Actual 3Q84 6/30/84	Actual 4Q84 9/30/84	Actual Year 84 9/30/84
Product Revenue	$108,474	$91,223	$119,064	$129,850	$448,611
Service & Other	17,895	20,012	22,861	23,240	84,009
Total Revenue	126,369	111,236	141,925	153,090	532,620
Cost of Revenue	50,437	47,245	57,787	63,341	218,810
% of Revenue	39.9%	42.5%	40.7%	41.4%	41.1%
R&D	10,849	12,853	13,514	15,298	52,514
% of Revenue	8.6%	11.6%	9.5%	10.0%	9.9%
SG&A	48,205	49,032	56,282	56,576	210,195
% of Revenue	38.1%	44.2%	39.7%	37.0%	39.5%
Operating Costs	109,491	109,230	127,583	135,215	481,519
Operating Profit	16,878	2,006	14,342	17,875	51,101
Oper. Profit Margin	13.4%	1.8%	10.1%	11.7%	9.6%
Other Income, Net	1,076	1,142	1,243	1,722	5,183
Pretax Income	17,954	3,148	15,585	19,597	56,284
Pretax Margin	14.2%	2.8%	11.0%	12.8%	10.6%
Income Taxes	7,900	1,174	6,335	7,667	23,076
Tax Rate	44.0%	37.3%	40.6%	39.1%	41.0%
Net Rate	10,054	1,974	9,250	11,930	33,208
Avg. Shares (000)	41,841	41,794	41,039	40,923	41,399
E.P.S.	$0.24	$0.05	$023	$0.29	$0.80

[Part 2 of 3]

	Estimate 1Q85 12/31/84	Estimate 2Q85 3/31/85	Estimate 3Q85 6/30/85	Estimate 4Q85 9/30/85	Estimate Year 85 9/30/85
Product Revenue	$137,500	$144,000	$155,000	$166,000	$602,500
Service & Other	24,000	25,000	26,500	26,500	103,000
Total Revenue	161,500	169,000	181,500	193,500	705,500
Cost of Revenue	66,538	69,628	72,963	75,852	284,981
% of Revenue	41.2%	41.2%	40.2%	39.2%	40.4%
R&D	15,989	16,900	17,787	18,963	69,639
% of Revenue	9.9%	10.0%	9.8%	9.8%	9.9%
SG&A	59,755	63,375	67,155	71,595	261,880
% of Revenue	37.0%	37.5%	37.0%	37.0%	37.1%
Operating Costs	142,281.5	149,903	157,905	166,410	616,499.5
Operating Profit	19,218.5	19,097	23,595	27,090	89,000.5
Oper. Profit Margin	11.9%	11.3%	13.0%	14.0%	12.6%
Other Income, Net	1,630	1,590	1,400	1,300	5,920
Pretax Income	20,848.5	20,687	24,995	28,390	94,920.5
Pretax Margin	12.9%	12.2%	13.8%	14.7%	13.5%
Income Taxes	8,443.6	8,378.2	10,123.0	11,498.0	38,442.8
Tax Rate	40.5%	40.5%	40.5%	40.5%	40.5%
Net Rate	12,404.9	12,308.8	14,872.0	16,892.1	56,477.7
Avg. Shares (000)	41,100	41,200	41,400	41,600	41,325
E.P.S.	$0.30	$0.30	$0.36	$0.41	$1.37(*)

[Part 3 of 3]

	Estimate 1Q86 12/31/85	Estimate Year 86 9/30/86
Product Revenue	$172,000	$780,000
Service & Other	284,00	120,000
Total Revenue	200,400	900,000
Cost of Revenue	78,356.4	348,300
% of Revenue	39.1%	38.7%
R&D	20,040	90,000
% of Revenue	10.0%	10.0%
SG&A	74,148	333,000
% of Revenue	37.0%	37.0%
Operating Costs	172,544.4	771,300
Operating Profit	27,855.6	128,700
Oper. Profit Margin	13.9%	14.3%
Other Income, Net	1,200	4,600
Pretax Income	29,055.6	133,300
Pretax Margin	14.5%	14.8%
Income Taxes	11767.5	53,986.5
Tax Rate	40.5%	40.5%
Net Rate	17,288.1	79,313.5
Avg. Shares (000)	41,750	42,700
E.P.S.	$0.41	$1.86(*)

(*) This is our "optimistic" model, our official estimates are $1.25 in fiscal 1985 and $1.75 in fiscal 1986.

(*) Drexel Burnham Lambert Incorporated makes a market in this security.

Table iii
Tandem Computers Inc.
Financial Summary

[Part 1 of 2]

Years to 9/30	Revenues ($000)	Pretax Income ($000)	Pretax Profit Margin	Effective Tax Rate	Net Income ($000)
1984	$532,620	$56,284	10.6%	41.0%	$33,208
1983	412,282	50,501	12.2	39.0	30,805
1982(R)	312,143	46,741	15.0	36.1	29,856
1981	208,397	51,098	24.5	48.0	26,549
1980	108,989	21,082	19.3	49.3	10,687
1979	55,974	10,104	18.1	51.3	4,920
1978	24,305	4,490	18.5	52.0	2,153
1977	7,692	329	4.3	52.0	158
1976	581	(2,169)	Def.	--	(2,169)
1975	--	(646)	Def.	--	(646)

[Part 2 of 2]

		Per Share Data (a)			
Years to 9/30	% Return on Yearend Equity	EPS	Div	Stock Price Range (b)	P/E Range (b)
1984	8.8%	$0.80	--	40-13	50-16
1983	9.9	0.76	--	40-24	53-32
1982(R)	11.9	0.76	--	33-14	43-19
1981	13.0	0.72	--	35-20	48-28
1980	15.2	0.35	--	33-14	43-19
1979	15.6	0.20	--	7-1	32-19
1978	13.9	0.10	--	6-2	60-22
1977	5.8	0.01	--	3-2(c)	N.C.
1976	Def.	(0.72)	--	--	--
1975	Def.	(0.25)	--	--	--

Notes:
(a) Adjusted for stock splits
(b) Calendar year for stock prices; P/E based on fiscal year earnings and calendar year prices
(c) Range since initial public offering 12/14/77
(R) Restated

Drexel Burnham Lambert
INCORPORATED

Research

Tandem Computers*

(TNDM-OTC)

Entering New Growth Phase

Gordon Casey

December 9, 1983

Price	52-Week Range	Earnings Per Share 1983A	1984E	1985E	P/E Ratio 1983A	1984E	1985E	Return on Avg. Equity	Dividend	Yield	Shares Outstanding
$36	$40-23	$0.76	$1.20	$1.65	47.4	30.0	21.8	11.0%	Nil	Nil	41,129,000

Fiscal year ends September.
* Drexel Burnham Lambert Inc. makes a market in this security.

POINT OF VIEW

- We reaffirm our strong Buy recommendation on Tandem. The company holds an excellent competitive position in the computer marketplace as the leading supplier of fault-tolerant systems. High demand for Tandem's NonStop systems has built a substantial user base in major corporations. Adding to the company's position in data processing is growing strength in computer networking.

- Tandem has made an excellent finish to fiscal 1983, an important year of transition for the company. Although fourth quarter and full year earnings were flat with 1982, the company achieved several key objectives in fiscal 1983. During the year, Tandem tightened accounting standards and significantly improved financial management.

- We expect Tandem to make significant earnings gains in fiscal 1984. The recently announced new generation of Tandem computers is expected to meet strong demand producing excellent revenue growth. We expect earnings to increase 58% in fiscal 1984 to $1.20 per share. Further strong gains are expected in fiscal 1985 to $1.65 per share.

- We believe Tandem has an exceptional potential for long-term growth. The company's leading position in fault-tolerant systems and growing strength in computer networking position Tandem to be a key player in the rapidly converging data processing and communications marketplaces. We project earnings growth in the 1982 to 1987 period averaging approximately 33% annually.

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OUTLOOK

The beginning of fiscal 1984 is an important turning point for Tandem as the company emerges from a difficult transition period in fiscal 1983. We expect Tandem to begin a period of renewed growth in fiscal 1984. Tandem pioneered fault-tolerant computer systems with the original NonStop I introduced in the mid-1970's. The company continues as the leading supplier of fault-tolerant transaction processing systems. High demand for Tandem's NonStop systems has built a strong user base in major corporations. Adding to the company's position in data processing is growing strength in computer networking. We believe Tandem has excellent potential for long-term growth. The company's strength in data processing and communications positions Tandem to be an important player in the marketplace of the mid-1980's.

A key factor in Tandem's improving outlook is the new generation of NonStop systems announced in October, 1983 at the beginning of the new fiscal year. The new Tandem NonStop TXP series of processors brings significant improvements in processing power and in price/performance. It is an important step for Tandem in maintaining competitive standing in the fault-tolerant marketplace and in providing an upward growth path for existing Tandem customers.

A critical consideration in Tandem's fiscal 1984 outlook is the phase-in of the new generation TXP processors. The new systems are currently being shipped. However, during the first half of the year, the earlier generation NonStop II will continue to play the principal role. Managing the product transition during this period will be a key challenge for Tandem.

We expect a tight first quarter with earnings flat with the $0.21 per share reported in the final quarter of fiscal 1983. Margins are expected to continue under pressure as marketing costs increase in the period of introduction for the new systems.

Results are expected to improve as production of the new systems accelerates. We expect revenue growth to increase from an estimated 35% in the first quarter to the mid-40% area by year-end. We estimate an overall 41% revenue gain in fiscal 1984 to $590 million. An increasing mix of the new TXP processors is expected to bring improved margins. However, Tandem currently has considerable excess capacity. We expect fiscal 1984 to be a catch-up period as increasing volumes gradually fill the underutilized facilities. We expect a 58% earnings gain in 1984, to $1.20 per share.

We expect Tandem's improving earnings trend, driven by the new systems, to continue into fiscal 1985. We expect Tandem's strength in computer networking to assume an increasingly important role in the mid-1980's. We estimate earnings growth in the 1982-1987 period averaging 33% annually.

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TABLE 1

SUMMARY FINANCIAL STATISTICS
($ millions except per share data)

	1980A	1981A	1982A	1983A	1984E	1985E
Revenue ($)	109.0	208.4	312.1	418.3	590.0	800.0
Rev. Increase (%)	94.7	91.2	49.8	34.0	41.0	35.6
Operating Income ($)	19.3	40.4	40.7	49.8	86.0	120.0
Operating Margin (%)	17.7	19.4	13.0	11.9	14.6	15.0
Interest Income (Net)	1.8	10.7	6.0	0.7	2.0	4.0
Pretax Income ($)	21.1	51.1	46.7	50.5	88.0	124.0
Pretax Margin (%)	19.3	24.5	15.0	12.1	14.9	15.5
Tax Rate (%)	49.3	48.0	36.1	39.0	41.0	41.0
Net Income ($)	10.7	26.5	29.9	30.8	51.0	73.0
Earnings Per Share ($)	0.35	0.72	0.76	0.76	1.20	1.65

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TABLE 2

SUMMARY FINANCIAL STATISTICS
($ millions except per share data)

	1982				1982A
	1Q	2Q	3Q	4Q	Total
Revenue ($)	71.0	74.1	79.8	87.2	312.1
Rev. Increase (%)	74.8	56.3	42.9	35.2	49.8
Operating Income ($)	11.4	8.4	10.5	10.4	40.7
Operating Margin (%)	16.0	11.4	13.1	11.9	13.0
Interest Income (Net)	2.3	1.3	1.5	0.9	6.0
Pretax Income ($)	13.7	9.7	12.0	11.4	46.7
Pretax Margin (%)	19.2	13.1	15.0	13.0	15.0
Tax Rate (%)	43.0	36.1	37.3	26.7	36.1
Net Income ($)	7.8	6.2	7.5	8.3	29.9
Earnings Per Share ($)	0.20	0.16	0.19	0.21	0.76

	1983				1983A
	1QA	2QA	3QA	4QA	Total
Revenue ($)	94.1	96.0	110.3	117.9	418.3
Rev. Increase (%)	32.6	29.6	38.2	35.1	34.0
Operating Income ($)	11.6	10.4	13.7	14.1	49.8
Operating Margin (%)	12.4	10.8	12.4	12.0	11.9
Interest Income (Net)	0.1	(0.2)	0.3	0.6	0.7
Pretax Income ($)	11.7	10.2	13.9	14.7	50.5
Pretax Margin (%)	12.4	10.6	12.6	12.5	12.1
Tax Rate (%)	39.0	36.9	39.3	40.2	39.0
Net Income ($)	7.1	6.5	8.4	8.9	30.8
Earnings Per Share ($)	0.18	0.16	0.21	0.21	0.76

	1984E				1984E
	1Q	2Q	3Q	4Q	Total
Revenue ($)	127.0	139.0	153.0	171.0	590.0
Rev. Increase (%)	35.0	44.8	38.7	45.0	41.0
Operating Income ($)	14.0	21.0	24.0	27.0	86.0
Operating Margin (%)	11.0	15.1	15.7	15.8	14.6
Interest Income (Net)	0.6	0.5	0.5	0.4	2.0
Pretax Income ($)	14.6	21.5	24.5	27.4	88.0
Pretax Margin (%)	11.5	15.5	16.0	16.0	14.9
Tax Rate (%)	41.0	41.0	41.0	41.0	41.0
Net Income ($)	9.0	12.0	19.0	16.0	51.0
Earnings Per Share ($)	0.21	0.29	0.33	0.37	1.20

Note: Fiscal year ends September.

BACKGROUND

Tandem entered the computer marketplace in the mid-1970's with a new approach to systems design. The Tandem NonStop system concept has provided new levels of computer reliability and availability. The company has translated this new computing concept into an outstanding record of business growth.

Tandem has concentrated upon the requirements for transaction processing systems in a variety of business-oriented environments. Systems are in use in a wide range of critical applications. The introduction of the computer to key business functions generally requires major changes in working procedures and the tasks that employees perform. The system becomes an integral part of the business function. Typical examples of transaction processing systems are airline reservations, on-line banking, and credit authorization. In these situations, continuous system availability is critical. The organization cannot function without access to the system.

Tandem achieves high levels of system availability with multi-processor-based systems. Throughout the system, multiple components and multiple data paths are provided. Operating system software has been designed to perform a wide range of system monitoring and management functions and to automatically perform corrective actions in the event of a system failure. The result is a set of products that continue to function effectively in the event of failure without loss or alteration of data.

Tandem has established an outstanding record of user satisfaction. Surveys consistently rate Tandem at the highest levels of product satisfaction and user loyalty. A key factor in these exceptional ratings is excellent software. The company's research and product development program includes a major commitment to software. The result has been a family of products which have significant advantages in initial installation and ease of expansion as well as high reliability.

Tandem's expertise in addressing the requirements for fault-tolerant systems has also resulted in a strong competitive position in computer networking. The company's emphasis on communications has intensified over the past two years with a series of important hardware and software announcements. Tandem's focus is increasingly oriented toward meeting the needs of large-enterprise users with massive networks employing thousands of terminals and hundreds of communications lines. Tandem's recent selection for a major U.S. Navy computer network underscores the company's growing stature in this vital opportunity area.

TABLE 3

CUSTOMER BASE AND PROCESSORS INSTALLED
CUMULATIVE TOTALS

	1976	1977	1978	1979	1980	1981	1982	1983
Customer Base	6	30	73	160	290	460	599	725
Processors Installed	12	81	257	646	1,299	2,509	4,051	5,824

Note: Fiscal year ends September.

PRODUCTS

Tandem's NonStop system architecture has been designed to provide continuous system availability. It is intended for on-line transaction processing applications. High availability is ensured by hardware parallelism and software which provides the ability to automatically reconfigure the system in the event of component failure. In addition, the NonStop design includes features to guard against loss or alteration of data.

The Tandem system is a multiprocessor design which can accommodate any combination of 2 to 16 individual processors. A modular approach is used, which provides a wide range of processing power and allows incremental growth as the user's needs increase. Modular upgrades can be made in the field without the need for a disruptive conversion.

The heart of the Tandem system, the NonStop processor, includes two microcoded processing units, one for central processing and bus control and a second for input/output control. This separation of functions frees the central processor of the burden of heavy input/output activity characteristic of transaction processing applications. In its present form, a 32-bit data access architecture is used, providing ample capacity to support the needs of the largest users. A dual bus structure is used for interprocessor connection. Throughout the system, multiple components and multiple data paths are provided. This includes multiple power supplies, input/output ports and controllers for peripherals.

The Tandem NonStop systems family has evolved in three steps since the first installations in May, 1976. During the first five years, the NonStop I clearly established Tandem as a leader in the computer marketplace. This new system established an impressive record of business growth. The NonStop I was focused primarily upon the needs of transaction processing applications. The unique fault-tolerant characteristics met enthusiastic user response.

Tandem's success in transaction processing led naturally to an increasing concentration on communications and geographically dispersed computer networks. The expanding requirements of Tandem's users created an opportunity for a more advanced version of the NonStop system. NonStop II was introduced in mid-1981 to meet these needs.

The principal change in NonStop II was the use of a 32-bit data access architecture that greatly expands memory addressability. This change was accomplished without sacrificing program compatibility with the original 16-bit NonStop I. A high degree of compatibility was maintained to ensure ease of migration for earlier customers. NonStop II provided the added capacity needed to support the largest computer networks, incorporating thousands of terminals and hundreds of communications lines.

A major additional feature of NonStop II was the inclusion of an operations and service processor (OSP) with each main processor. The OSP monitors system operation and provides system status and diagnostic functions, as well as facilities for unattended remote operation of the system. These functions are vital in the operation of large computer networks which frequently have unattended equipment in remote sites.

The latest step in the evolution of Tandem's systems is the NonStop TXP introduced in October, 1983. In undertaking this new-generation NonStop system, the company has concentrated product development efforts on extending Tandem's strong competitive position in fault-tolerant transaction processing systems. The aim has been to apply advanced semiconductor technologies to improving Tandem systems while maintaining compatibility with existing installations. The company has emphasized nondisruptive conversion in the development of the NonStop TXP.

Tandem's new series of processors brings significant improvements in processing power and in price/performance. It is an important step for Tandem in maintaining competitive standing in the fault-tolerant marketplace and in providing an upward growth path for existing Tandem customers.

The NonStop TXP has 2 to 3 times the computing power of the previous NonStop II system. Price/performance is improved by a factor of 2. The new system is fully software compatible with the current systems and requires no program conversion. In addition, the new processor modules are physically compatible with existing hardware and can be installed within existing housings on a 2-for-1 basis. This enables users to modularly upgrade installed systems with a mix of NonStop II and TXP processors within the same system.

In addition to the new TXP processors, Tandem has announced the 6100 communications controller. This is an important addition to the company's communications and networking offerings. The new controller

off-loads the communications line management job from the Tandem NonStop System. The controller is also designed for fault-tolerance and offers improved flexibility of operation. The announcement is significant in further strengthening Tandem's capabilities in the fast-growing computer networking arena.

The Tandem product lineup now includes roles for each of the three NonStop generations. The new TXP processors provide high system performance for large transaction processing installations and major computer networks. The TXP system has an entry level price of $325,000.

The NonStop II will continue to be available to fill the need for medium volume nodes in large networks. Selective price reductions make a basic two-processor entrylevel NonStop II available for $195,000, down from $270,000 previously. Below this, reconditioned NonStop I systems will be available with an entry price of $100,000. In our opinion, the new lower entry prices will help Tandem to counter new fault-tolerant competitors with systems priced in the $140,000 to $200,000 area.

COMPETITION

Tandem has established a unique competitive position by emphasizing fault-tolerant systems. The NonStop concept originated with Tandem and has been the key factor in differentiating the company's products. The concentration on transaction processing requirements and fault-tolerance has established a strong niche in the marketplace. User attitudes appear to favor fault-tolerant systems in an ever wider range of applications. In our opinion, fault-tolerance will ultimately be expected in any advanced on-line application.

The strong demand for Tandem's systems and the growing user acceptance of fault-tolerant concepts has not gone unnoticed by competitors. A widening array of computer suppliers have announced fault-tolerant systems, or have indicated that fault-tolerant systems are being developed.

The competitive response to Tandem has evolved along two basic paths. New start-up companies are proposing new architectural approaches to fault-tolerance. The current generation of low-cost microprocessors facilitates the entry of these new contenders. In contrast to this, existing companies are typically advocating a computer-networking, or software-based approach, which maintains compatibility with existing hardware. However, in every instance, the competitive approaches are significantly different from Tandem's products.

Tandem's initial start-up challenger, and the most visible new company, is Stratus Computers of Natick, Massachusetts. This new contender is targeting the same transaction processing marketplace with

similar fault-tolerant characteristics. Initial efforts focus on business and commercial applications while using independent systems houses for marketing. The first shipments were made in early 1982 and by September 1983 Stratus was celebrating the shipment of the hundredth system. Stratus has taken a significantly different architectural approach. Extensive use has been made of currently available microprocessors that emphasize a high degree of redundancy. The low hardware cost of the new products has allowed Stratus to utilize a hardware solution to fault-tolerance.

An October 1982 announcement by IBM indicated a limited endorsement of fault-tolerance by the industry leader. New operating software for the IBM Series 1 minicomputer allows up to 16 processors to operate in parallel while appearing to the operator like a single system. This provides several advantages of nondisruptive system growth, improved reliability and redundancy in case of failure of an individual processor.

In our opinion, the choice of the Series 1 by IBM restricts this offering to a limited segment of the market. The Series 1 has been marketed by IBM as a conventional minicomputer and does not have the broad array of software and installation aids which are available for other IBM products. Series 1 installations typically require significant customer effort or the services of a third party system integrator. Viewed one year after the announcement, the IBM product has primarily been used by existing Series 1 customers. It has not been actively marketed by IBM as a general purpose fault-tolerant system.

Digital Equipment has also announced fault-tolerant capabilities in the April, 1983 introduction of VAXcluster. The new DEC offering includes new hardware and software to interconnect DEC VAX processors. It provides a loosely coupled system which enables the user to share software and data files within a complex of up to 16 VAX processors. The VAXcluster provides modular growth by adding new processors to the network. The software supports a wide range of file sharing and data integrity functions. Although it does not support the full range of fault-tolerant features, it does provide modular expansion. Many users view the ease of expansion of Tandem's systems as their principal advantage.

Our assessment of VAXcluster is that it is aimed primarily at meeting the growth needs of the present users of large VAX processors. Many users of the top-end VAX 11/780 require added system capacity to meet their growth needs. DEC's planned larger VAX has been seriously delayed. In the interim, we expect DEC to market VAXcluster primarily as an upgrade for existing VAX users. Later, we expect DEC to reorient VAXcluster toward opportunities in the fault-tolerant marketplace.

Both IBM and DEC have chosen to add new software to existing systems to provide improved reliability. Both companies are marketing

several systems in the small and intermediate systems marketplace. In contrast to Tandem, these processors were designed to minimize the cost of single-processor installations. We believe IBM or DEC would be reluctant to introduce a completely new series of processors without first rationalizing the conflicts and overlaps between existing products. However, longer term we expect the concept of fault-tolerance to become a key consideration in systems design. By the mid-1980's we expect the established companies to offer new hardware incorporating these considerations.

Our view concerning Tandem's competition is that the demand for highly reliable transaction processing systems is massive and capable of supporting many suppliers. In our view, Tandem's lead in software development provides a substantial advantage relative to the new contenders. Tandem has built an excellent user base with systems installed in over 700 major corporations worldwide. This creates a strong position for future growth. In some respects, these customer commitments can preempt the entry of new suppliers. The customer's investment in applications software and growing familiarity with Tandem's concepts tend to confine a new entrant to completely new situations. We do not expect increased competitive activity to threaten Tandem's projected business growth.

TANDEM'S REORIENTATION, 1982 AND 1983

The past two years have been a pivotal period for Tandem. The company closed out fiscal 1981 with revenue almost double that of the previous year. Results in early fiscal 1982, as originally reported, indicated a continued strong rate of revenue growth exceeding 80% in the first half. Expectations for fiscal 1982 indicated a year of exceptional growth constrained only by Tandem's ability to add resources and supply products.

Tandem's outlook began to change with the company's mid-1982 announcement of weakening order patterns. Deteriorating economic conditions were beginning to constrain Tandem's virtually unbounded growth.

The Tandem picture changed further with the December, 1982 announcement that the previously reported fiscal 1982 earnings were to be restated. The restatement became necessary to satisfy the objections of Tandem's outside auditors in their review of the full year's results. The specific area of concern was revenue recognition practices.

Tandem's auditors raised two basic issues. The company had credited shipments actually made after the September 30, 1982 year-end and also credited shipments that in the judgment of the auditors did not have adequate documentation. The auditors did not question the validity of the orders and shipments involved, but merely the timing of revenue recognition.

Correction of the revenue recognition problem not only involved restatement of past results but required Tandem to implement further accounting changes in fiscal 1983. During each quarter, Tandem followed a program of progressive tightening of revenue recognition practices. At the end of the first quarter, Tandem credited shipments that would be installed within 30 days in the U.S. and within 45 days outside the U.S. Tightening standards during the year reduced these levels by approximately 5 days per quarter. The year-end target levels were 15 days in the U.S. and 20 days outside the U.S. During fiscal 1983 Tandem derived 30.3% of revenue outside the U.S.

Tandem's tightened revenue recognition significantly changed the ongoing growth picture. On a restated basis, fiscal 1982 earnings of $0.76 per share were up only 6% over $0.72 per share in 1981. This was well down from a reported 32% gain in the preliminary report before restatement. Fiscal 1983 results were impacted similarly as the company implemented tighter standards at the end of each quarter. Although earnings of $0.76 per share in fiscal 1983 were flat with 1982, they represent higher quality earnings reported on a more conservative basis.

Additional problems surfaced as growth slowed and accounting practices were changed. During fiscal 1982, costs grew significantly as the company failed to adjust rapidly enough to the reduced growth outlook. A further problem was excess capacity as new facilities came on-stream with the completion of programs that had been committed to during the higher growth period. The continued overcapacity was a key factor in the weak fiscal 1983 results.

Fiscal 1983 was an important year of consolidation for Tandem. We believe the company has made significant progress in correcting the problems that have impacted results. In addition to accounting changes, the company has effected many administrative and procedural changes to improve operations. Financial management functions have been strengthened and the company now has a chief financial officer. In our opinion, Tandem's improving outlook is being recognized and investor perceptions of Tandem are significantly improved.

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TABLE 4

RECENT RESULTS
FISCAL 1982 (RESTATED) AND 1983
($ millions except per share data)

	1982				1983			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Revenue ($)	71.0	74.1	79.8	87.2	94.1	96.0	110.3	117.9
Rev. Increase (%)	74.8	56.3	42.9	35.2	32.6	29.6	38.2	35.1
Cost and Expenses								
Cost of Revenue ($)	25.2	26.7	27.0	30.5	38.0	37.9	45.1	47.8
Product Devel. ($)	6.8	7.7	9.2	9.9	9.0	9.8	10.0	10.4
Marketing, G&A ($)	27.6	31.3	33.2	36.4	35.5	37.9	41.6	45.6
Total ($)	59.6	65.7	69.3	76.8	82.5	85.6	96.6	103.8
Cost and Expenses as a % of Revenue								
Cost of Revenue (%)	35.5	36.0	33.8	35.0	40.3	39.4	40.9	40.5
Product Devel. (%)	9.6	10.4	11.5	11.3	9.6	10.2	9.0	8.8
Marketing, G&A (%)	38.9	42.2	41.5	41.7	37.8	39.5	37.7	38.7
Operating Income ($)	11.4	8.4	10.5	10.4	11.6	10.4	13.7	14.1
Operating Margin (%)	16.0	11.4	13.1	11.9	12.4	10.8	12.4	12.0
Interest, Net ($)	2.3	1.3	1.5	0.9	0.1	(0.2)	0.3	0.6
Pretax Income ($)	13.7	9.7	12.0	11.4	11.7	10.2	13.9	17.7
Pretax Margin (%)	19.2	13.1	15.0	13.0	12.4	10.6	12.6	12.5
Tax Rate (%)	43.0	36.1	37.3	26.7	39.0	36.9	39.3	40.2
Net Income ($)	7.8	6.2	7.5	8.3	7.1	6.5	8.4	8.8
Earnings Per Share ($)	0.20	0.16	0.19	0.21	0.18	0.16	0.21	0.21

Note: Fiscal year ends September.

TABLE 5

CUSTOMER SHIPMENTS BY QUARTER

	1982				1983			
	1	2	3	4	1	2	3	4
Processors Shipped*	405	390	373	374	396	370	386	621
Customers Shipped to	120	113	114	132	116	119	115	159
New Customers	42	28	29	40	35	25	19	47

* Processors shipped reported on a net-shipped basis. Trade-ins of NonStop I processors for NonStop II processors were a significant factor up to 3Q1983 when the trade-in program ended.

MANAGEMENT

From the company's founding in 1974, Tandem has worked to create a strong base for future growth. The company's founding management, including the president, James G. Treybig, and his three co-founders, received their basic grounding at Hewlett-Packard. They brought with them a philosophy based upon "people-oriented" management. The company is committed to a wide variety of advanced and unorthodox management and personnel practices. Long-range planning has been a key area of focus in building an organization capable of propelling Tandem into the billion-dollar class. The Tandem style emphasizes informality, open communication and respect for the individual employee and his role in the company. The Tandem philosophy is based upon the belief that the individual's effort is key to good products and a successful business. Self management and peer pressure are emphasized. Responsibility and decision making are pushed down to the working level.

The difficult transition period of 1982-83 revealed some weaknesses of Tandem's management approach. The organization and procedures that worked in the company's early fast-growth period were found to be inadequate when growth moderated. This was particularly true in the area of financial controls and management.

Tandem is currently operating under a program of relative austerity in comparison to the previous period. The challenge is to maintain the company's strengths while imposing additional controls. We expect the company to undergo some changes in this process of maturing. Tandem has experienced some losses of key management personnel. However, in our opinion, these losses have been small considering the long period of transition Tandem has passed through. Tandem's ability to retain key people has been an outstanding strength of the company. The company's low 12% turnover rate is in sharp contrast to many of its Silicon Valley neighbors with 30% to 40% rates. We believe Tandem has the ability to attract the management talent needed to maintain strong business growth. We view the loss of some key management personnel as inevitable in this period of reorientation of the company. We do not view these factors as a constraint to Tandem's growth.

PRODUCT DEVELOPMENT AND MANUFACTURING

Product development and principal manufacturing operations are carried on at Tandem's headquarters location in Cupertino, California. This main location has been expanded considerably as the company has grown. Some supporting subassembly and printed circuit board operations are carried on in Watsonville, California. In addition, the company has established a development and manufacturing facility in Austin, Texas with the primary mission of producing the 6530 terminal family. Supplementing these production locations, Tandem maintains systems integration and testing facilities in Neufahrn, West Germany;

Santa Clara, California, Reston, Virginia and Bensenville, Illinois.

A key factor in the weak earnings pattern in fiscal 1983 was pressure on earnings brought about by excess manufacturing capacity. At the end of the fiscal year, the company had significant overcapacity at Watsonville, Austin and Reston. Continued business growth in fiscal 1984 is expected to eventually bring capacity into line by the end of the year.

Tandem operates largely as a systems integrator, performing the functions of product design, subassembly manufacturing and final assembly and test. Extensive use is made of outside sources for components and subassemblies. Approximately 80% of subassembly production is carried on in Tandem facilities with the remainder sourced from subcontractors. System peripherals, including disk drives and tape drives are obtained on an OEM basis from independent suppliers. This approach is designed to enable the company to concentrate its efforts on critical product areas. The principal examples of this focus on key products are the new 6100 communications controller and the 6530 terminal family.

TABLE 6

CAPITAL EXPENDITURES 1979 TO 1984E
($ thousands)

	Property, Plant & Equipment At Cost At End of Previous Year	Additions to Property, Plant & Equipment	Increase (Percent)
1979	$ 3,168	$5,433	172%
1980	8,519	9,966	117
1981	18,365	25,974	141
1982	44,339	63,677	144
1983	107,466	27,814	26
1984 (Estimated)	132,772	55,000	41

Note: Fiscal year ends September.

Emphasis on research and product development has been a key factor in establishing Tandem's unique position of leadership in the marketplace. The company has consistently committed to high levels of research and development spending. During fiscal 1983, Tandem committed 9.4% of revenue to product development. Product development efforts are balanced between hardware and software activities. From the company's founding, Tandem's management has worked to create an environment that would attract and retain exceptional research and development talent.

We believe the commitment to quality development work is amply evi-

denced in the company's products and in high levels of user satisfaction. We expect these factors and the strong budget commitment to ensure continuation of Tandem's strong position in the marketplace.

TABLE 7

RESEARCH AND DEVELOPMENT EXPENDITURES 1979 TO 1984E
($ Thousands)

	Revenue	Research and Development Expenditures	Percent of Revenue
1979	$ 55,974	$ 4,654	8.3%
1980	108,989	8,786	8.1
1981	208,397	17,833	8.6
1982	312,143	33,642	10.8
1983	418,282	39,168	9.4
1984 (Estimated)	590,000	53,000	9.0

Note: Fiscal year ends September.

FINANCIAL

Tandem grew rapidly following shipment of the first NonStop system in May 1976. The company's fast pace required frequent infusions of new capital. Four public stock offerings were made in the period from fiscal 1978 to fiscal 1981. In addition, the employee stock purchase plan and stock options have become an increasingly significant source of funding. Table 8 summarizes stock sales from the initial public offering in December, 1977.

Tandem entered the difficult 1982-83 period well provided with funds from the December 1980 stock sale. The lower growth in this period reduced basic funding requirements. The substantial cash usage in fiscal 1982 was reversed in fiscal 1983 as the company emphasized cost cutting and asset management. Tandem concluded fiscal 1983 with cash and cash investments of $93.5 million, a substantial gain over $24.8 million at the beginning of the year.

We expect Tandem to resume strong business growth in fiscal 1984. We believe the company has the proven product leadership and the strong user base necessary to ensure future growth. We expect Tandem to continue the steady recovery from the setbacks of fiscal 1982-83. Margins and return on investment are expected to improve. We estimate earnings growth in the 1982 to 1987 period averaging 33% annually.

We are estimating a 41% revenue gain in fiscal 1984, driven by accelerating shipments of the new TXP processors. We expect the strong

pattern of growth to continue into fiscal 1985. We believe current levels of cash are adequate to meet funding needs in fiscal 1984. Our analysis assumes an additional $100 million in equity during fiscal 1985 derived half from employee purchases and half from a public offering. Tandem plans to begin construction of a major new facility located in San Jose, California in 1985. We expect the company to seek additional funding in advance of actual requirement. However, Tandem has the option of long-term debt or convertible securities to meet funding needs. In our opinion, Tandem's ability to grow is not constrained by the ability to obtain additional funding.

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TABLE 8

TANDEM COMPUTERS INC.
COMMON STOCK SALES
($ thousands)

	1978	1979	1980	1981	1982	1983
Sale Prior To Public Offering*	1,000	---	---	---	---	---
PUBLIC OFFERINGS						
Date	(12/77)	(12/78)	(11/79)	(11/80)		
Net Proceeds	7,888	10,075	24,279	96,033	---	---
EMPLOYEE SALES						
Options	---	354	2,042	7,396	5,050	19,095
Purchase Plan	---	408	950	2,273	7,199	5,936
Total Employee Sales	310	762	2,992	9,669	12,249	25,031
TOTAL STOCK SALES	9,198	10,837	27,271	105,702	12,249	25,031

* Sold as preferred stock subsequently converted to common stock at initial public offering. Equity sales prior to fiscal year 1978 totalled $5,225,260.

Note: Fiscal year ends September.

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INCORPORATED

TABLE 9

OPERATING RETURNS
($ millions)

	1979A	1980A	1981A	1982A	1983A	1984E	Average Percent Increase
Operating Return on Tangible Assets* (%)	34.1	30.5	25.1	16.8	16.8	19.3	---
Current Assets	39.3	81.7	220.1	242.0	310.8	382.0	57.6
Net Plant & Equipment	6.6	14.1	35.9	89.4	98.8	135.0	82.9
Operating Income Before Depreciation	11.6	21.6	44.2	49.9	65.9	106.0	55.6
Interest Expense	0.1	0.3	0.3	1.0	2.8	1.0	57.9
Interest Expense/Operating Income Before Depreciation (%)	0.8	1.3	0.6	1.9	4.4	0.9	---
Debt Leverage** (%)	7.9	7.8	5.3	16.5	16.5	14.7	---
Long-term Debt***	1.1	1.7	2.1	21.1	23.9	24.0	85.3
Debt in Current Liabilities	0.4	0.5	0.7	2.1	3.3	5.0	65.7
Deferred Taxes	1.0	3.3	8.1	18.1	24.0	30.0	97.4
Total Equity	31.5	70.3	204.8	251.0	311.0	402.0	66.4
Return on Equity (%)	20.9	21.0	19.3	13.1	11.0	14.3	---

* (Operating income + depreciation)/Average tangible assets
** (Short-term debt + long-term debt + deferred taxes)/Total equity.
*** Long-term debt + capitalized lease obligations.

Note: Fiscal year ends September.

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TABLE 10

TANDEM COMPUTERS
SOURCES AND APPLICATIONS OF FUNDS 1980-1985
($ millions)

Sources of Funds	1981A	1982A	1983A	1984E	1985E
Net Income	$26.5	$29.9	$30.8	$51.0	$73.0
Depreciation	4.1	10.2	18.8	21.0	30.0
Other	4.8	9.9	5.9	10.0	12.0
Total From Operations	35.5	50.0	55.5	82.0	115.0
Applications of Funds					
Accounts Receivable	28.1	28.1	20.7	40.0	55.0
Inventory	33.6	46.8	(15.4)	30.0	45.0
Prepaid Expenses	3.1	12.0	(5.2)	10.0	20.0
Prepaid Expenses, Current Liabilities and Other Assets	(17.1)	5.8	(12.9)	(5.0)	(10.0)
Total Used	44.3	80.7	(7.6)	75.0	110.0
Sources Minus Applications	(8.8)	(30.7)	63.1	7.0	5.0
Additions to Property, Plant and Equipment	26.0	63.7	27.8	55.0	80.0
Net Funds Used	34.8	94.4	(35.3)	48.0	75.0
Funds Provided By Financing Sources					
Misc. Debt	0.5	13.1	(4.1)	---	---
New Financing	108.0	16.3	29.2	40.0	100.0
Total From Financing Sources	108.5	29.4	33.3	40.0	100.0
Total Funds Used	(73.7)	65.0	(68.7)	8.0	(25.0)
Cash - Beginning of Year	16.2	89.8	24.8	93.5	85.5
Cash - End of Year	$89.8	$24.8	$93.5	$85.5	$110.5

Note: Fiscal year ends September.

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TABLE 11

TANDEM COMPUTERS
CONSOLIDATED BALANCE SHEETS
($ millions)

	September 30 1982	September 30 1983
Assets		
Current Assets		
Cash and Investments	$ 24.8	$ 93.5
Accounts Receivable (Net)	98.8	119.6
Inventories	101.3	85.9
Other	17.0	11.8
Total Current Assets	$242.0	$310.0
Property, Plant and Equipment (At Cost)	107.5	132.8
Less Depreciation	(18.1)	(34.0)
Net	$ 89.4	$ 98.8
Other Assets	6.0	6.0
Total Assets	$337.4	$415.5
Liabilities and Net Worth		
Current Liabilities	$ 47.2	$ 56.6
Capitalized Lease Obligations	10.4	15.4
Long-Term Debt	10.7	8.5
Deferred Income Taxes	18.1	24.0
Total Liabilities	$ 86.4	$104.5
Net Worth	$251.0	$311.0
Total Liabilities and Net Worth	$337.4	$415.5

Note: Fiscal year ends September.