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—Raúl Rojas

DBMS See Database Management Systems.

DB2

DB2 is a **database management system** (DBMS) sold by **IBM**, whose market share in this segment of the software industry was about 30 percent in 2000. DB2 runs on a variety of **operating systems**, including OS/2, **Windows** and **Windows NT**, variations of **Unix**, and IBM's OS/390 and OS/400. There are currently more than 3 million DB2 installations.

DB2 is a relational database—that is, data are stored in tables (*relations*) that can be queried using a special language such as **SQL**. This language was developed by IBM and in the late 1970s was put into the public domain. The first relational database sold by IBM was SQL/DS, released in 1981, which was replaced two years later by DB2, a database for IBM mainframes. DB2 has continued to evolve since its introduction, adding new features every year and also new variations of SQL. Being an SQL-based language, DB2 provides data definition, data manipulation, and a data control language.

DB2 is one of the few examples of software that moved successfully from the **mainframe** to smaller computers. IBM added the suffix UDB to DB2 to indicate that it is now a universal database. The key objective of IBM has been to position DB2 at the center of "complete solutions," by offering many other software products that access the DB2 server software. To implement this strategy, all DB2 groups within IBM were fused into a single group that wrote unified code for all platforms.

To couple the database with applications, DB2 provides a functionality that makes programming with this system easier. An interface exists for most common programming languages, so that DB2 queries can be started from within a program. Also, it is now possible to access DB2 databases through the **World Wide Web**.

The latest release of DB2 added support for data warehouses and online analytical processing (OLAP). IBM's intention is to provide *scalability*—that is, the capability of greatly increasing the size of a database—and *extensibility*, which refers to interfacing future applications to DB2. This is the case of electronic commerce on the Web, for which no definite standards exist.

The largest producers of database systems are IBM, **Oracle**, **Microsoft**, Informix, and Sybase, in that order. Although IBM had lost market share in the 1990s, it became the leading database vendor after switching to its "universal" strategy. The database market is expected to grow to U.S$10 billion by 2003, and DB2 is expected to continue to be one of the principal DBMS products.

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—Raúl Rojas

Debugging

The word **bug** as a synonym for a computer programming error has been in use for more than 60 years. Debugging refers to the process of finding and removing errors in programs.

Usually, the programmer examines a program's source code, trying to identify the offending portion. In more complex situations, a debugging tool allows the user to go step-by-step through a program, setting breakpoints at specified statements and examining the values of variables. The first debuggers worked only with **assembler** language, but there are modern debugging tools for high-level programming languages which interpret a program line by line. The debugger for the language **Prolog**, for example,

even allows the programmer to run the program backwards, in order to return to a situation encountered previously.

Software is always buggy. For that reason, software manufacturers perform a series of tests before releasing a program. The in-house assessment is usually called the *alpha test.* Then the program is *beta tested* by distributing prerelease copies of the product to outside users, who try hard to crash the program. This jargon derives from **IBM** terminology of the 1960s, in which an A-test was done for components and a B-test was the initial system test. Sometimes programs that work perfectly become buggy after a certain time: A perfect example is the **Y2K problem**, which affected programs that used only two digits to record the year and could not recognize dates after the year 2000.

The most effective debugging tool is good programming. Many errors can be avoided right from the beginning by using a syntax-sensitive editor, which will, for example, detect trivial syntax errors. A good specification of the program is also essential. Software engineering is the discipline that sets guidelines for programming and quality control of complete software products. The whole aim of computer-aided software engineering (CASE) tools is increasing the productivity of programmers while reducing the number of errors.

The challenge is that debugging needs to examine almost all conceivable possibilities in a program. Automated software tests attempt to achieve this by making a program try many possible inputs. A protocol of the test is stored in case the program crashes. The operating system **Unix** is a good example: It always stores a copy of the contents of main memory when a process crashes, so that the programmer can make a postmortem assessment of the possible bug. The file produced is called a *core dump.*

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—*Raúl Rojas*

Dell Computer

Dell Computer Corporation, headquartered near Austin in Round Rock, Texas, and still under the leadership of its founder Michael Dell (1965–), is the world's largest direct-sales computer systems company. Believing that the future of computing lay in the then-largely untapped home-user market, in 1984 Michael Dell created Dell Computer Corporation. The new company differentiated itself by being the first to sell personal computers by mail order directly to home-based customers (rather than retailers), while maintaining strong ties with business, government, and educational clients.

In June 1988, Dell became a public corporation with an initial offering price of U.S.$8.50 per share; in October 1999, a share purchased at the initial offering price was worth nearly U.S.$4000. Quarterly revenues in the late 1990s regularly topped U.S.$5 billion, and Dell boasted the second-highest growth rate among all major computer systems companies worldwide.

Much of Dell's phenomenal growth has been attributed to its innovative marketing and distribution strategies. Besides being the first to sell directly to its home-based customers, Dell also pioneered the build-to-order business model for computers: Computer systems are assembled to client specifications only after they have been ordered. In this way Dell was able to reduce prices and undercut competition while providing customers with unique systems. Part of Dell's strategy was to develop direct relationships with its customers, be they home users or representatives of the world's largest corporations. Sales were direct from Dell without retailers adding unnecessary time and cost.

Dell was also among the first to use the **Internet** to sell its computer systems; in the late 1990s it was the industry leader in this area. Besides using the Internet for sales, Dell's **World Wide Web** site was expanded to provide around-the-clock support for its customers, including customized diagnostics over the Web. By 1999, Dell offered a wide range of services, including system installation and management, technology transition support, and training. The design of custom products and services meeting the customer require-