

**Daisy Wheel: Growth/Direction/Future**

## **Daisy Wheel: Growth/Direction/Future**

A speech given by Joseph C. Sanchez, President,  
Diablo Systems, Inc., to Dataquest, Inc.  
in New Orleans, Louisiana on March 27, 1980  
Authored by J. C. Sanchez and T. R. Charter

**Diablo Systems Incorporated**  
A Xerox Company

Diablo<sup>®</sup>, XEROX<sup>®</sup>, and HyType<sup>®</sup> are trademarks of XEROX CORPORATION.

© 1980 Diablo Systems Incorporated

# Daisy Wheel: Growth/Direction/Future

A speech given by Joseph C. Sanchez, President, Diablo Systems, Inc.

Until 1972, the IBM Selectric mechanism set the office standard for quality printing output. Because its price, speed, and reliability were unmatched, systems designers had no other alternatives in their selection of a quality output device for word processing systems. As a result, they were forced to "work around" many undesirable limitations imposed by the technology of the time.

The Selectric was composed of over 3,000 mechanical parts which confined its operating speed to 15 characters per second and placed serious limitations on its reliability. Repetitive typing applications where WP systems could offer significant improvements were restricted by output speeds only slightly greater than the original keyboarding speed. Its high-mass-in-motion design, which contributed to the Selectric's excellent print quality, also produced an undesirable high impact noise level.

In the terminal and emerging minicomputer markets, Teletype's Model 33 and 35 were well established as the primary low-speed output devices for time sharing and scientific applications. Although the Teletype price was certainly afford-

able, its speed, limited character set, roll fed paper, and reliability left much to be desired.

Then, in 1972, came the daisy wheel printer. Diablo Systems pioneered the development of this technology, borrowing from our previous DC servo experience with disk memory devices. Our basic design approach in the creation of the daisy wheel printer made possible product capabilities previously unavailable to the system designer.



*Diablo HyType II*

The thousands of mechanical linkages, levers and controls contained in other types of printers were replaced with solid state electronics which reduced the component count tenfold. This reduction in mechanical content allowed print speeds to increase to 30 cps immediately and permitted a subsequent

jump to the current speed of 60 cps.

Solid state electronics significantly improved reliability even at the increased printing speeds. Fewer moving parts and low-mass-in-motion also resulted in a reduced noise level which allowed for the acceptance of high-speed printing in an office environment.

Some of the benefits of the new technology are shown in Figure 1 which compares Diablo's HyType II serial printer with two other types of printers: the IBM Selectric and the KSR 33.

The impact of daisy wheel technology in the markets we serve has been significant:

- The word-processing market has come to expect high-speed, quality output. Most CRT word-processing systems support output devices that are three to four times faster than printers used eight years ago.
- 110-baud terminals are obsolete. 300-baud performance is now the minimum performance standard being designed today.
- And, although the daisy wheel printer (due to its mechanical nature) is still the least reliable element of most mini-com-

	<b>IBM Selectric</b>	<b>KSR 33</b>	<b>HyType II</b>
<b>Speed</b>	15 CPS	10 CPS	30-60 CPS
<b># of Components</b>	Thousands	Thousands	Hundreds
<b>Reliability</b>	<1000 hr MTBF	<1000 hr MTBF	2000 hr MTBF
<b>Noise</b>	70-75 dba	High	65-70 dba
<b>Price</b>	\$800	\$600	\$1000
<b>Quality</b>	Excellent	Fair	Good -- Excellent
<b>Font Capability</b>	88 interchangeable	64 fixed	96 interchangeable

Figure 1

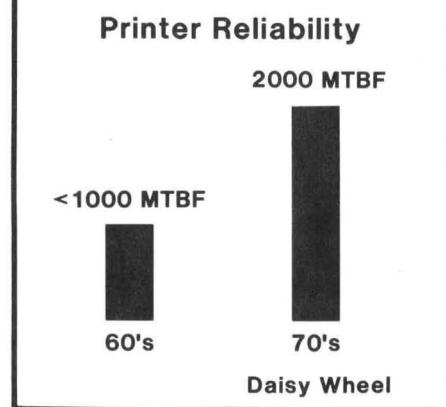


Figure 2

puter systems, it is a significant improvement from the less than 1,000 MTBF printers of the 1960's, as shown in Figure 2.

Today, according to Dataquest estimates, there are over 350,000 daisy wheel printers installed. This success can be attributed to superior print quality, high speed, low product cost, and improved reliability. (Figure 3.)

## Company History

Diablo was the pioneer in the development of this technology, and I would like to take a few minutes of your time to bring you up-to-date on our company.

Diablo was founded in July 1969, by George Comstock, as a developer and manufacturer of highly reliable, low-cost electro-mechanical peripheral equipment for minicomputers, small-to-medium business systems, and the data communications markets. We concentrated on OEM accounts in marketing this equipment.

Production delivery of Diablo's first product, the Series 30 disk drive, began in August 1970. Diablo introduced the first daisy wheel HyType printer mechanism in 1972; in that same year, the company was acquired by the Xerox Corporation. In 1977, Diablo started production on the Model 3200 intelligent terminal or small business system which was marketed—and still is—through a network of independent distributors. Thus, during the 1970's, Diablo's focus was divided among three separate business areas: printers/terminals, rigid disk memory devices and programmable products. (Figure 4.)

In 1979, Diablo went through a major change in terms of the company's primary business activity. We transferred our rigid disk memory products to Century Data Systems, a Xerox operating division, and shifted our programmable products business area to the Office Products Division of Xerox located in Dallas.

These changes will permit Diablo, during the 1980's, to concentrate on developing and manufacturing quality, serial, character printers,

## Daisy Wheel Printers Installed

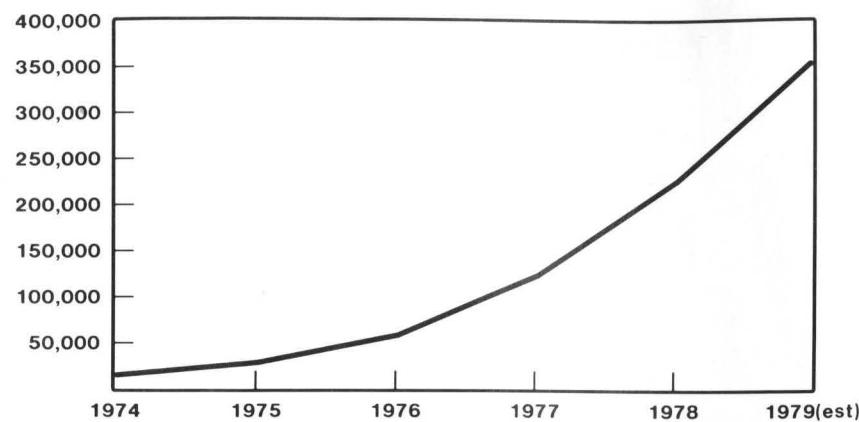


Figure 3

## Diablo's Business Focus -- 1970's

**1969**

**Rigid Disk -- Series 30**

**1972**

**Daisy Wheel -- HyType I  
Xerox Acquisition**

**1977**

**Programmable Products -- Ranger 3200**

Figure 4

using all technologies that present opportunities for low-cost, high-reliability and high-quality products. (Figure 5.)

We will continue to emphasize volume distribution through OEM and distributor sales channels. Less than ten percent of Diablo's printer production goes to other Xerox operating divisions, though we expect this to increase somewhat. Diablo does not currently supply any printers for Xerox word processing equipment.

## Printer Applications by Market Segment

Diablo sees the daisy wheel printer selling into four application areas: document creation or word processing, terminals, business systems, and retail or personal computing. (Figure 6.) The demand for daisy wheel printers in each of these

areas has resulted primarily from the market emphasis and desire for low-cost, reliable, high-speed, quality output. (Figure 7.)

In 1972, prior to the strong independent surge in word processing, daisy wheel printers found initial acceptance in the move to 300-baud in the data communications market. At that time, there was a large installed base of 110-baud terminals and an equally large base of users who wanted better quality and higher speed. The 300-baud bidirectional printing capability of HyType I met this need for improved performance. During the early years of HyType shipments, probably 50 percent of our volume went into this market segment and, in spite of the growth of CRT terminals, the demand for HyType terminals continues to grow.

Word processing became the

## Diablo Focus for the 1980's

- Quality, serial, character printers and accessories up to 5 pages/min
- All technologies that present opportunities for products that are
  - low cost
  - high reliability
  - high quality
- Volume distribution through OEM and distributor channels

Figure 5

major growth opportunity for everyone in the second half of the 70's. The print quality, reliability and throughput requirements of this application made daisy wheel technology an immediate success.

Growth in the area of business systems has paralleled that of word processing. By business systems, I mean those activities made possible by the development of the mini-computer and micro-computer technologies. Distributive data pro-

sing, data entry and small business systems all required a low-cost, reliable, output printer. Daisy wheel printers answered this market need, along with the matrix technology which supported those applications where speed was more important than print quality. As business systems companies have added word processing applications to their standard software, the daisy wheel printers have become equally important to this growing market.

Retail or personal computing probably represents the most significant growth area, although its potential is not yet fully understood. This market segment does not deal with new applications, but rather with new channels of distribution. In just a few short years, its placement rate for computer systems has equaled or exceeded that of all other segments. Here, the major applications are word processing and very small business systems. The placement of computers into the consumer marketplace via the retail store is undoubtedly the next great market opportunity for computer systems. And, even though there are lower-cost alternatives, daisy wheel technology figures significantly in this segment. The need for quality continues to exist even in a cost-sensitive market.

### Daisy Wheel Performance

Within the context of the previously defined market segments, let me briefly discuss the current performance band for daisy wheel technology and touch on its future direction.

The chart in Figure 8 compares the current print resolution and speed of daisy wheel printers with the performance of other types of

#### Market Segments

- Document Creation (Word Processing)
  - BTW - Buffered Typewriter (Low-End)
  - S/S - Stand Alone/ Shared Logic
- Terminal
  - OEM
  - Distributor
- Business Systems
  - EDP Support
  - Small Business Systems
  - Laboratory and Computational
- Retail (Personal Computing)
  - Very Small Business Systems
  - Professional/Scientific
  - Consumer

Figure 6

### Daisy Wheel Opportunities by Market Segment

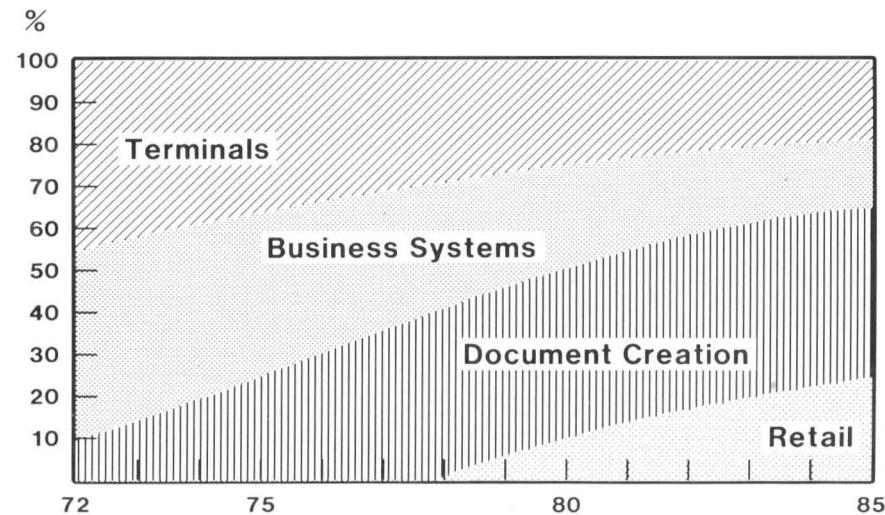


Figure 7

printing technologies. Daisy wheel technology concentrates on high-quality printing at prices and speeds that permit distributed low-volume printing.

In what future direction is daisy wheel technology headed? Due to the asynchronous nature of its printing operation (i.e., character positioning is not synchronized with carriage positioning), it does not seem reasonable to expect this technology to produce significantly higher print speeds without disproportionate increases in cost.

We expect print quality to stay the same or perhaps improve to some degree in terms of wheel life, quality and cost. (Figure 9.)

Acoustical noise is an area of increasing concern in the office environment. Government regulations and some union contractual requirements underline the importance of this inherent problem when dealing with high impact energies. Improvement in hammer technology should reduce noise levels during the 1980's.

The need for an increased number of characters on-line continues to grow as word processing is applied to the fields of engineering, science, medicine and law. The current dual-head approach adopted by a number of vendors solves the problem but extracts a significant price premium from the user. It seems certain that a better solution will become available during the 1980's.

At present the speed/price band on the daisy wheel printers is quite narrow; speeds from 35-60 cps are available within a 15 percent price spread. (See Figure 10.) In the near term, a greater price/performance spread will occur as new technologies enter the low-speed categories, reduce the basic component count and thus cut cost. In the long term, this new technology will be improved in performance and eventually will have a similar impact on the high-speed segment, thus narrowing the price band once again. The overall impact will be to reduce the cost of the printing function. However, increased emphasis on

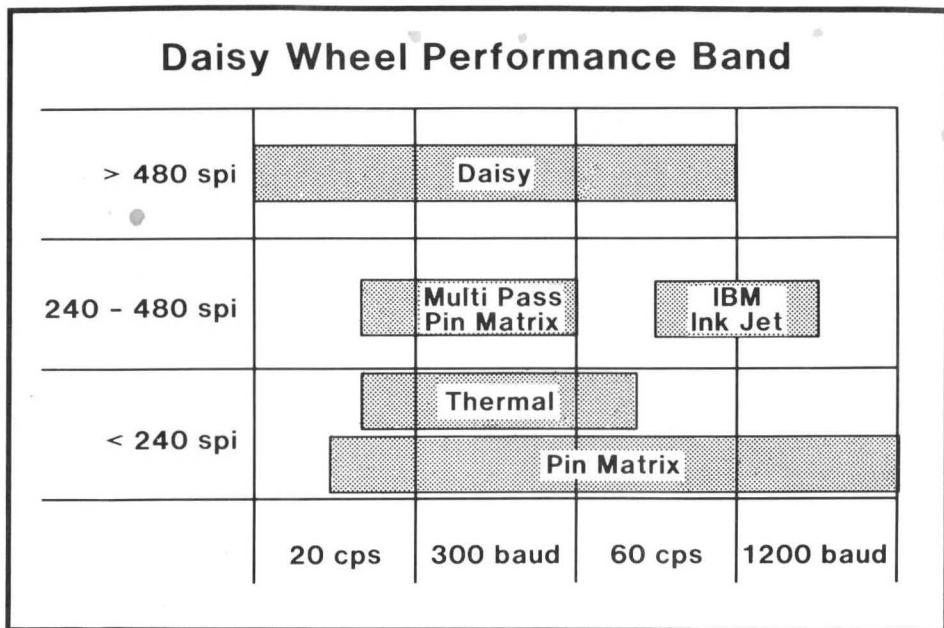


Figure 8

### Daisy Wheel Future Direction

	1970's	1980's
Speed	20-60 CPS	No Change
Quality	Good -- Excellent	No Change
Noise	65-75 dba	Less
Font Capability	96-100	More cost effective solution to extended font requirements
Paper Handling	Minimal	Extended

Figure 9

### Daisy Cost/Speed Trends

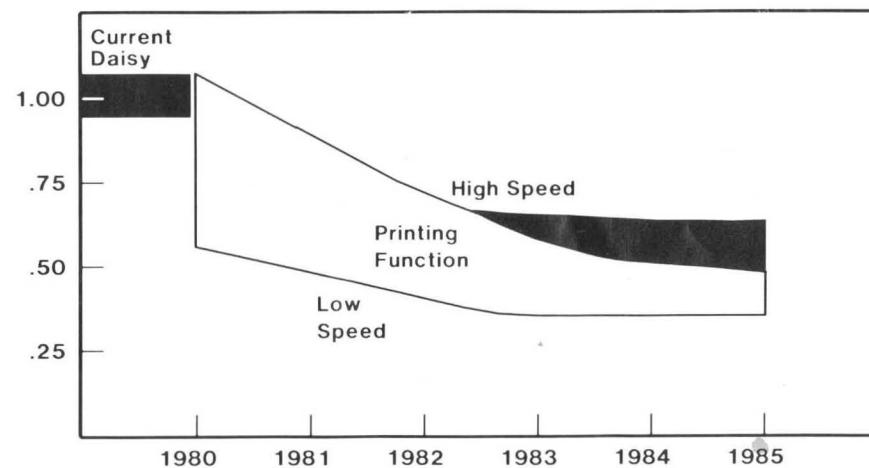


Figure 10

added features, such as paper handling, extended character sets, and greater interface intelligence will

create a widening of the price band to accommodate the nonprinter functional costs.

## Technology Cost Relationship

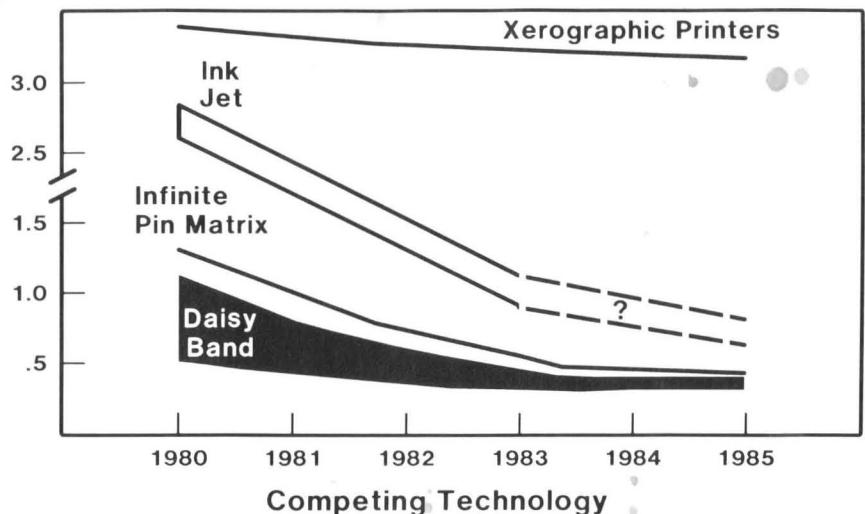


Figure 11

### Feature Comparison

	Pin Matrix	Ink Jet	Daisy
Speed	30-100 CPS	100 CPS+	60 CPS
Noise	60-70 dba	40-50 dba	60-70 dba
Fonts	Software	Software	Hardware
Print Quality	Fair - Good	Good	Good - Excellent
Reliability	Good	???	Good

Figure 12

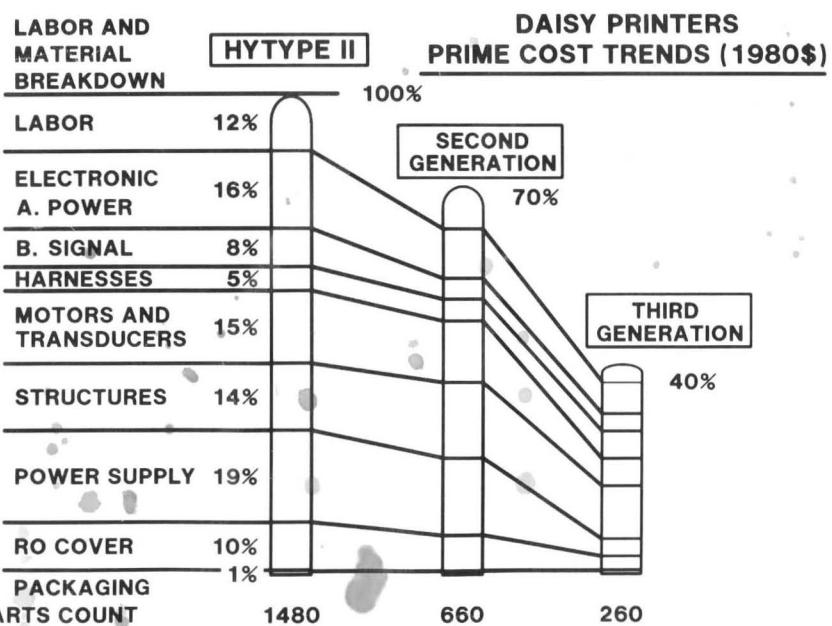


Figure 13

## Competing Technologies

What are the technologies that have the potential to catch up to the daisy wheel? The graph in Figure 11 compares the technology/cost relationship of ink jet, infinite pin matrix, xerographic and daisy wheel printers.

As the daisy wheel printer moves down the cost curve, so do the pin matrix and ink jet printing systems. Pin matrix probably has the greatest opportunity to catch up to the daisy wheel. In our opinion, however, the pin matrix's primary difficulties will be to gain wide-spread user acceptance and to stay in a price range competitive with the daisy wheel in a high-resolution 60 cps performance band.

The great unknown with respect to ink jet is its reliability and cost of ownership: can it become a reliable enough product to operate as a \$4,000 printer as opposed to a \$25,000 printer? If so, its features will make ink jet the most serious source of competition to the daisy wheel. (Figure 12.)

## Daisy Wheel's Future

What then is the outlook for daisy wheel technology versus new technological developments? First, note in Figure 13 that the daisy wheel is not a stationary target. It is moving aggressively down its own technology curve and learning curve. In 1985 (constant 1980 dollars) daisy wheel performance should cost about 50 to 70 percent of today's cost, depending on speed and other performance requirements. Additional features to look for in daisy wheel technology include:

- A family of products will be available that share a common set of major subassemblies.
- A complete set of paper handling equipment configurable into a printer system will be available for applications requiring unattended operation.
- Increased use of microprocessor technology will continue to improve printer reliability.
- A decreased MTTR will be made

possible by improved diagnostics, simplified mechanical design and prealigned sub-assemblies.

- Logistics cost saving will be made possible by:
  - A common set of sub-assemblies
  - Improved reliability
  - Improved MTTR.

## Summary

The daisy printer throughout the 80's promises to be of major value to systems suppliers with an expanded role in lower-cost document creation systems and small business systems, with a possible eventual role in personal computing. To a large degree, the limits of this expansion will be dictated by cost. Additional function and value will be available with a wider array of accessories for improving end-user efficiency, throughput and up time.

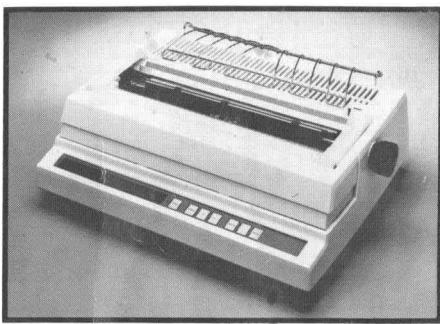
Some of our thoughts regarding product and market direction are embodied in our new Model 630.

## The Model 630

The Model 630 is a new low-cost serial impact printer that produces letter quality output for OEM word processing, data processing and communications applications. It is an extension of the current product

line offering an expanded set of features.

This new printer is the first of its type to use plastic and metalized print wheels interchangeably. Printing speed varies from 32 to 40 characters per second depending upon type of print wheel, type style and text.



Diablo Model 630

Model 630 printers use all of the more than 100 different Diablo and Xerox plastic and metalized print wheels—88, 92 and 96 characters in 10 or 12 pitch or true proportional spacing. The new printers also use all HyType II ribbons, including multi-strike, fabric and two-color fabric ribbons.

- It offers a variety of paper handling options, including friction and pin-feed platens. Other standard HyType II form-feed subsystems can also be used, including the HyFeed cut sheet feeder, the mechanical front feed, and both unidirectional

and bidirectional forms tractors.

The new units support two types of interfaces: an RS-232C interface for communications applications, and a microprocessor interface that permits direct attachment of the printers by OEM's and systems builders to a wide variety of small office and data processing systems.

The extensive use of advanced components—such as LSI circuitry, microprocessor controllers, and denser packaging of control electronics—has enabled Diablo to reduce the number of parts in the new unit while improving overall machine reliability.

The distinctive packaging design reduces the physical profile of the Model 630 printer and dramatically simplifies the configuration of the basic mechanism. The new design affords even greater reliability than other current Diablo models because there are fewer moving parts. Decreasing the number of parts also simplifies maintenance and eliminates many adjustments that would otherwise be required to maintain optimum print quality.

Initial delivery of production units of the Model 630 is scheduled for April 1980.

Thank you for your time. On behalf of everyone at Diablo, I'd like to invite you to visit our offices in Hayward, California.

# Diablo Systems Incorporated

A Xerox Company

24500 Industrial Boulevard, Hayward, California 94545  
(415) 786-5000, Telex 910-338596