COMMUNICATION INTELLIGENCE CORPORATION (CIC)

Computer Recognition of Natural Handwriting

Since the beginning of the computer age during World War II, virtually all data have been entered into computers via the keyboard. Teletype machines were adapted so that typing created a punched paper tape, which was read by a second device attached to the computer. Later, the key-punch machine was developed; it created holes in cards that were read by a card reader connected to the computer. In time, keyboards were used to enter data directly into computers, first via terminals connected to mainframe computers, and then for desktop computers as well.

COMPOSITE PERFORMANCE SCORE
(Based on a four star rating.)
★ ★

Handwriting: An Easier Way to Enter Computer Data

Each development advanced the science of data entry, but keyboards have continued to be problematic. Some people cannot use them because of physical limitations, such as arthritis or carpal tunnel syndrome, or because they do not know how to type. Others find them difficult to use in particular settings and circumstances, such as conducting inventory on the shop floor or a geology survey in the wilderness, where using a keyboard is cumbersome. Difficulty in using keyboards and their inappropriateness in certain situations were seen as two of the obstacles limiting computer use to only about five percent of the U.S. population when this project was proposed in ATP's first competition in 1990.

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Software That Recognizes Cursive Writing

Communication Intelligence Corporation (CIC), a small California company spun off from SRI International (formerly Stanford Research Institute), has addressed these keyboard problems by using technology created in its ATP project for a reliable, cost-effective alternative: a stylus and pad that can be used by the computer to read handwriting. The hardware was simple to implement, since touch-sensitive pads already existed. The difficult part was perfecting techniques for software that would effectively recognize fully cursive handwriting.

CIC researchers accomplished this technical goal during

A computer user entering information into her PC with a pad and stylus. Company software in the PC converts the data from the pad into letters and words.

PROJECT HIGHLIGHTS

PROJECT:
To develop a natural handwriting data-entry system for computers for applications where pen-based entry works best and for use by people who do not or cannot use a keyboard.

Duration: 4/1/1991 — 9/30/1993

ATP Number: 90-01-0210

FUNDING (in thousands):

ATP	$1,264	58%
Company	912	42%
Total	$2,176	

ACCOMPLISHMENTS:
CIC developed new data-entry software technology that recognizes each user's natural handwriting without training the computer or the user. The company:

- incorporated some of the ATP-funded technology into an existing software product, Handwriter®, giving it the ability to recognize connected letters in cursive writing in limited circumstances (previously, it recognized only handprinting);
- licensed the Handwriter® software to more than a dozen computer manufacturers around the world, generating $360,000 in revenue from sales of 30,000 units in 1997;
- launched a new product in 1996 called Handwriter® Mx™, a stylus-and-tablet data-entry device using the upgraded Handwriter® software;
- sold 11,000 copies of Handwriter® Mx™ in 1997, with sales totaling more than $2.2 million; and
- received, in early 1997, the "Ease-of-Use Seal of Commendation" from the Commendation Program of the Arthritis Foundation, for the company's Handwriter products — indicating their value to disabled people who have trouble with keyboard entry.

COMMERCIALIZATION STATUS:
The ATP-funded software technology is widely licensed, and a new product fully incorporating the software is due on the market soon. Both are generating revenue.

OUTLOOK:
The outlook for this technology is strong, since it opens up possibilities for much wider use of computers and expanded market opportunities for U.S. producers of hardware and software. The potential is likely to increase further as languages other than English are incorporated into the approach. The company is actively seeking additional market opportunities for further distribution of its products.

Composite Performance Score: ★ ★

COMPANY:
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Number of employees: 33 at project start, 93 at the end of 1997

the project by collecting a database with thousands of cursive handwriting samples and developing new recognition algorithms. After analyzing the handwriting-sample database and developing the recognition methods, they also developed procedures that permit fast computation with modest computer memory requirements.

New and Upgraded Products

Prior to its ATP project, CIC was marketing a software product called Handwriter®, which could recognize handwritten printing but not cursive writing. The company has now incorporated some components of the ATP-funded technology into Handwriter®. Even though the technology for recognizing fully cursive handwriting has been developed, the upgraded software currently available commercially cannot yet read fully cursive handwriting. It is able, however, to recognize connected letters in cursive writing in limited circumstances. CIC has licensed Handwriter® to most of the PC manufacturers in the world, and the upgraded Handwriter® software is now incorporated in a number of pen-based, hand-held computer devices on the market.

The company also developed two new consumer products based on the ATP-funded technology. One product is Handwriter® Mx™, which includes a stylus and pad, as well as the upgraded Handwriter® software. In late 1996, CIC began marketing Handwriter® Mx™ in a large computer chain, with a retail price of about $200. The other product, Handwriter® fx™, also contains the upgraded software but has a larger writing pad and other features useful to graphics artists. In early 1997, CIC began marketing it in the same computer chain. During that year, the company sold more than 11,000 units of these two products, generating revenues in excess of $2.2 million.

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Company officials say the Handwriter® software will be upgraded again in the near future to fully recognize cursive handwriting. One barrier to complete implementation of the ATP-funded technology has been the need for tuning the software system to operate with the standard amount of memory available in modern desktop computers and to run fast enough to keep up with a typical person's handwriting speed. That obstacle is now being addressed.

. . . thousands of cursive handwriting samples . . .new recognition algorithims . . . fast computations . . .

Broadening Access to Computers

CIC's handwriting-recognition system should prove extremely beneficial. Computer users are now able to enter data via the digitizer tablet, as well as by keyboard or other means. This advance makes computers more useful for more people, especially those whose keyboard use is limited by physical problems or other circumstances. Other computer users may find a note-taking stylus a useful adjunct to the keyboard. For some jobs, particularly those that involve field work, the pen-based computer is the only reasonable solution, and the benefits of having it may be quite high for the user.

As more languages besides English are added to the software, users who write in these languages will benefit from using a handwriting input device that readily accepts all manner of handwriting styles. Markets for hardware and software should expand in response to wider use of computers and related products.

ATP Partnership Speeds Technology Development

ATP's participation in this project advanced development of the technology by 18 to 24 months and improved the company's credibility with commercial partners. This credibility was important in establishing the licensing and manufacturing relationships needed for rapid commercial deployment of the technology.

The history of this ATP project offers a good example of the amount of time needed by a well-run program to both develop and commercialize a new technology. CIC estimated at the start of the project in 1991 that the overall research, development, and marketing effort needed to get to market would take four to five years. In 1996, three years after completing the two-and-a-half year ATP research project, the company launched Handwriter® Mx™, and in 1998, seven years from the time the project began, the company was nearing release of a new software version that fully met the original goals.

Help for Victims of Arthritis

In early 1997, the Arthritis Foundation awarded CIC its "Ease-of-Use Seal of Commendation" for the company's Handwriter products. The Foundation's Commendation Program, founded in the late 1980's, recognizes products and packaging that are particularly accessible and easy to use. The award followed a favorable review by health professionals and arthritis patients.

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