ACCUWAVE CORPORATION

Expanding the Number of Light Signals in an Optical Fiber

Over the last two decades, the use of optical fiber as an alternative to metal wire and cable has exploded. Optical fiber is now the technology of choice for use undersea and for most terrestrial applications of more than the shortest distances.

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

No Stars

More Light Signals Per Optical Fiber

This ATP project with Accuwave Corporation, a small California company specializing in the development of holographic communications systems, created a way to substantially increase the number of signals that can be transmitted in a single strand of fiber-optic cable. The new technology is designed to enable the transmission of 80 or more channels per fiber. If adopted, it could eventually reduce the cost per transmission and save hundreds of millions of dollars over a period of just a few years.

. . . multiwavelength light enters one end of the crystal and encounters a series of holographic gratings . . . that separate the light signals of different wavelengths.

A Unique Holography-Based Approach

The new technology is based on the concept of wavelength division multiplexing (WDM), which transmits light of more than one wavelength through a single optical fiber, separating the individual wavelengths at the receiver. Such systems must discriminate among the different wavelengths and so are limited by the accuracy of the multiplexing and demultiplexing optics.

Accuwave had previously developed a unique approach to WDM using volume holography: holograms "written" in the interior of thick crystals of photorefractive (light-bending) materials. In the demultiplexer crystal, for example, multiwavelength light enters one end of the crystal and encounters a series of holographic gratings — each tuned to deflect a specific wavelength of light — that separate the light signals of different wavelengths. Accuwave had demonstrated the individual elements of a system that could multiplex wavelengths more than 10 times better than the current state of the art at visible wavelengths. With its ATP funding, Accuwave extended its technology to the infrared wavelengths used for long-distance telecommunications, and designed a prototype WDM system.

. . . another company beat it to market with a competing system operating in the same infrared wavelengths.

Accuwave officials report that ATP funding enabled it to develop WDM for signal transmission, a task it would otherwise have been unable to do. In addition, receiving the ATP award helped the company form important alliances with research partners during the ATP project (not identified here for confidentiality reasons).

PROJECT HIGHLIGHTS

PROJECT:
To develop holographic-optics technology that will increase (by more than 10 times) the number of signals that can be transmitted through a single optical fiber.

Duration: 3/1/1993 — 3/14/1995

ATP Number: 92-01-0055

FUNDING (in thousands):

ATP	$1,987	69%
Company	898	31%
Total	$2,885	

ACCOMPLISHMENTS:
Accuwave developed a process for producing photorefractive materials suitable for fiber optics telecommunications applications. The company also:

- received two patents for technologies related to the ATP project:
  "Photorefractive Systems and Methods (Divisional)"
  (No. 5,684,611: filed 6/6/1995, granted 11/4/1997) and
  "Wavelength Stabilized Laser Sources
  Using Feedback From Volume Holograms"
  (No. 5,691,989: filed 9/14/1993, granted 11/25/1997);
- applied for two additional patents for technologies related to the ATP project;
- completed pilot production of wavelength division multiplexing (WDM) components designed for incorporation into equipment manufactured by other companies, and introduced the components in 1996;
- signed a purchase agreement with a major telecommunications equipment manufacturer;
- raised $4 million from venture capitalists and other investors since 1990; and
- built a plant and ramped up volume production in 1998.

CITATIONS BY OTHERS OF PROJECT'S PATENTS: See Figure 4.1.

COMMERCIALIZATION STATUS:
In 1996 and 1997, Accuwave introduced three WDM system components: wavelength controllers, wavelength lockers and fiber-optic collimators. The company continued to pursue its original goal of selling WDM products for fiber optics telecommunications applications.

OUTLOOK:
Despite the heretofore promising prospects for growing applications of this technology in the telecommunications sectors, the commercialization outlook at this time is bleak. As this report was going to press in late 1998, it was learned that the company had ceased operations and was in the process of declaring bankruptcy. While it is possible that the technology will be picked up by other companies and carried forward in the future, at this point there is insufficient information about the likelihood of this to comment further on the outlook.

Composite Performance Score: No Stars

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Number of Employees: 5 at project start, 16 at the end of 1997

Marketing Disappointment Spurs Alternative Commercialization

Near the end of the ATP funding period, while Accuwave was trying to raise additional private capital to complete the technical work on its WDM system and sign commercialization agreements with potential customers, another company beat it to market with a competing system operating in the same infrared wavelengths. Nonetheless, Accuwave continued to work toward completion of its WDM multiplexer, which it believes provides multiplexing capabilities of higher signal accuracy, with more channels per fiber and in a smaller package than the products offered by competitors.

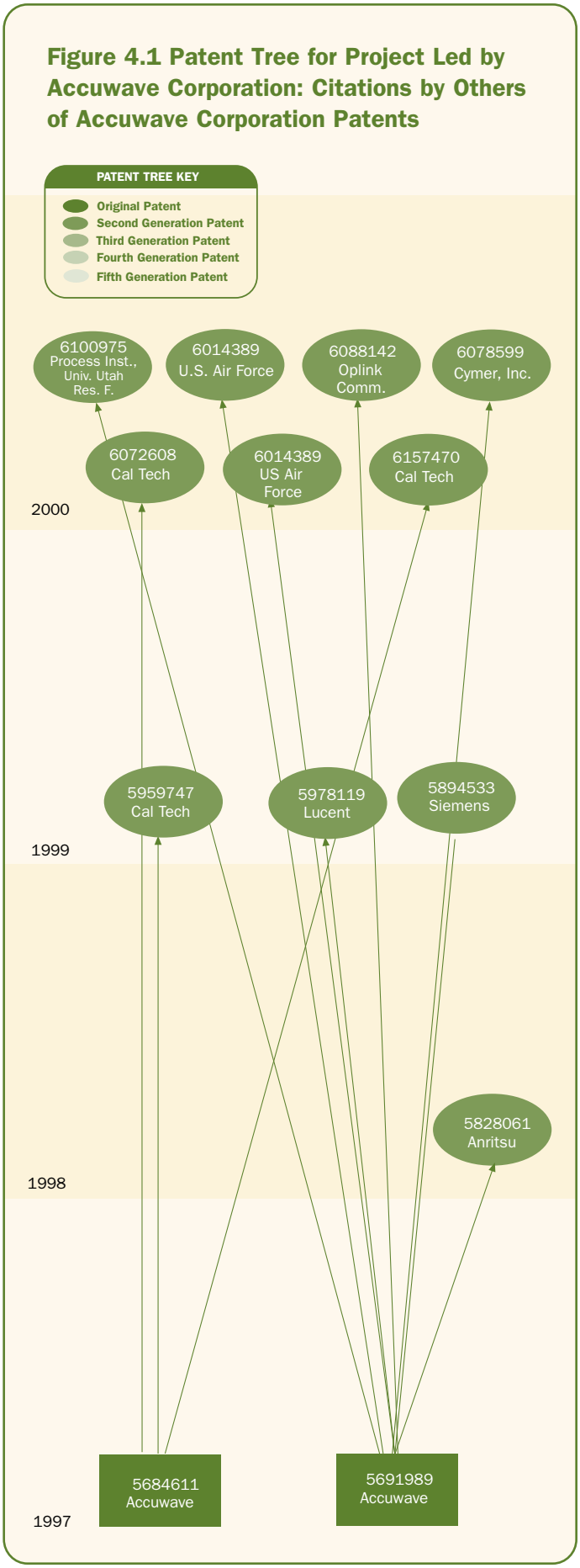
. . . launched several component products based on the ATP-funded technology.

Although Accuwave did not succeed in its original commercialization plans for sale of a WDM system in the bulk-signal-transmission market, it launched several component products based on the ATP-funded technology. These include wavelength controllers, wavelength lockers, and fiber-optic collimators, all of which are being sold to producers of WDM systems. The company developed contacts with potential telecommunications clients in Europe, Japan, and Brazil, as well as the United States, and it planned to introduce its own wavelength multiplexers in the near future.

Potential Big Savings in Telecommunications

With its potential to increase the number of signals that a single optical fiber can carry, the Accuwave technology could significantly affect the cost of communications via fiber-optic cables, particularly if used for undersea applications. Because of the volume of messages transmitted via this medium, cost savings would be great, even if the number of signals per fiber were doubled. The Accuwave technology has the potential to double and redouble the number of signals per fiber many times over, with the count possibly reaching as many as 80 signals per fiber.

Figure 4.1 Patent Tree for Project Led by Accuwave Corporation: Citations by Others of Accuwave Corporation Patents



In addition to applications in the bulk-signal-transmission market, the ATP-funded technology has the potential of providing greater cable bandwidth to homes and offices for use with high-definition TV and to the closed-circuit TV market, particularly for security

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uses. The company was interested in pursuing these potential applications, but instead used its resources to develop the WDM system for telecommunications applications. The technology also has potential applications in ultranarrow band filters, spectrometers and optical disk memories.

As this report was going to press in late 1998, it was learned that the company had ceased operations and was in the process of declaring bankruptcy. It is possible that the technology will be picked up by other companies and carried forward in the future.