Laser Power Corporation

Commercializing Red-Green-Blue Microlaser Technology to Revolutionize Projection Displays

Increased demand for bigger, brighter, and higher resolution large-screen, high-definition televisions and projection displays prompted a joint venture between Laser Power Corporation and Proxima Corporation to explore the use of laser technology to meet this demand. As relatively early-stage companies, the joint venture partners lacked sufficient internal funds for research and development, while other more established firms considered the use of lasers in projection displays as too risky to meet the required rate of return for private funding. In short, the joint venture had the necessary expertise and vision, but it lacked the funds to develop projection displays that could be purchased or manufactured through licensing and placed in a variety of products. Co-funding from the Advanced Technology Program (ATP) allowed the companies to pursue the development of a high-resolution multimedia laser projection display. The joint venture successfully developed red-green-blue microlasers and prototyped a projector display unit. Although commercialization of the display unit was not cost effective, the microlasers were applied to a wide variety of other displays. Laser Power Corporation sold the microlaser technology to Melles Griot, which continues to develop it.

COMPOSITE PERFORMANCE SCORE
(based on a four star rating)
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Research and data for Status Report 94-01-0133 were collected during Ocober – December 2001.

Projection Displays Viewed as the Wave of the Future

Difficulty in manufacturing large-screen, direct-view liquid crystal displays and cathode ray tubes (CRTs) led many developers to believe that projection displays would be the wave of the future for large-screen, high-definition television (HDTV). Furthermore, developers thought projection displays would penetrate the existing market for direct-view, CRT-based television.

At the time this project was proposed, the idea of using a laser to project high-resolution images was groundbreaking.

Therefore, Laser Power Corporation (LPC) entered into a joint venture with Proxima Corporation to develop a high-resolution, multimedia laser projection display and to then pursue a higher risk, higher payoff technology that addressed super-resolution HDTV requirements for large-screen applications. The success of this project hinged on commercializing LPC's red-green-blue (RGB) microlaser technology, which, if successful, would revolutionize the projection display market. At the time this project was proposed, the idea of using a laser to project high-resolution images was groundbreaking. As promising as the idea was, however, a joint venture involving two relatively early-stage companies could not attract a source of funds to enable the necessary research.

More established firms, for example, considered the research and development expense of using lasers as too high to generate required rates of return on either internal or other sources of private funding.

In 1995, the joint venture submitted a proposal to ATP for cost-shared funds to conduct its research and development. The project's goal was to achieve a 1,000-lumen, 10-lumens-per-watt projection display on a screen that is approximately 90 inches diagonal and combines HDTV resolution with 24-bit color. At the project's conclusion in 1997, LPC had successfully developed RGB diode-pumped, solid-state microlasers to produce full-color images that had extremely high resolution and brightness. Of all the project's achievements, the microlaser development was the most impressive.

LPC Overcomes Technical Risks in Microlaser Development

Development of the blue microlaser source had the highest technical risk. When the project first started, LPC could generate no more than 10 milliwatts (mW).Through the ATP project, the company overcame many technical challenges to develop what was referred to at the time as the most powerful commercially available blue microlaser, exceeding 780 mW at 457 nanometers (nm). At the end of the program, LPC was focused on improving the operating life of the blue microlaser unit.

One of the most significant outcomes of the ATP project was the advancement of the microlaser technology and the positive impact on a variety of other laser-based display initiatives.

Although the blue microlaser was the most noteworthy of the three microlasers developed, the output levels of the green and red microlasers were also increased significantly. Initially, LPC was unable to produce more than 300 mW of green microlaser power. By the end of the project, it had developed its most powerful laser, which could produce 4.4 W at 532 nm. This achievement represented a 15-fold improvement in power for the green laser, without an alteration in the quality of the green light. In addition, by the end of the project, LPC had improved red microlaser production from an initial output of 90 mW to 1.6 W at 656 nm.

Although LPC attained the desired level of output for the red microlaser, it was unstable and unreliable at that power level. LPC had to temporarily lower output power and change power sources to make the red microlaser more stable. Despite the problems, the company still views the development of the red microlaser as a significant achievement.

ATP Project Spurs Additional Industry Benefits

The successful development of these three diode-pumped, solid-state microlasers enabled LPC to continue its research and development initiatives. The company incorporated the microlasers into various display units with Proxima Corporation and with other companies seeking to benefit from the resulting increase in resolution. Moreover, both LPC and Proxima successfully completed several other planned objectives.

As a result of the ATP project, LPC's other contributions included light-shaping development, beamlet formation, polycrystalline lanthanum-modified lead zirconate titanate modulator development, scanner development, and optical system design. Proxima's contributions included modulator driver development, video electronics development, and color gamut transformation.

LPC's Research and Development Efforts Span Public and Private Sectors

One of the most significant outcomes of the ATP project was the advancement of the microlaser technology and the positive impact on a variety of other laser-based display initiatives. For example, shortly after the start of the ATP project, LPC was awarded funds to develop a 1280 by 1024 resolution (color pixel) system for Armstrong Laboratories, research that ran concurrently with the ATP-funded research.

Based on the results of both the ATP project and the Armstrong Laboratories research, Armstrong awarded LPC an additional contract that focused on developing an even higher resolution projector. This new projector was to be used in a flight simulator and needed a resolution of 5000 by 4000 (compared with the resolution of standard broadcast television, which is 480 by 640).

Following the conclusion of the ATP project, LPC continued to pursue other initiatives with both Armstrong Laboratories and other private-sector and

government entities. For example, under the sponsorship of the Defense Advanced Research Projects Agency, LPC began developing a digital-color version of the direct-write projector and head-mounted displays.

Further leveraging its established industry relationships, LPC developed a full-color, laser projection display test bed, which was based on highly efficient RGB microlasers. These high-power, high-efficiency microlasers have repeatedly proved to be the critical component in high-resolution, high-brightness, laser projection displays. The microlasers also have been applied to multiple backlight laser projectors and multiple direct-write displays.

LPC Addresses Safety Concerns with Lasers

LPC also conducted eye safety evaluations to ensure that the new products are safe for commercialization. The company hired Dr. Myron Wolbarsht, the author of *Safety with Lasers and Other Optical Sources* and a recognized legal expert in the field of laser safety.

Laser products are classified on a scale of I to IV, based on the degree of hazard posed by the output beams. After careful analysis, Dr. Wolbarsht determined that LPC's projector could be manufactured to conform to a Class II laser classification, rather than the higher power, more dangerous Class III level. Class II lasers are low power (less than 1 mW) and are visible-light lasers that can possibly cause damage to one's eyes. Some examples of the use of Class II lasers are laser pointers, aiming devices, and range-finding equipment.

LPC Sells Microlaser Business Unit

After the conclusion of the ATP-funded project, LPC began marketing green and blue microlaser products to medical and other customers. The company manufactured these products in a low-volume fabrication facility. LPC planned to expand its capabilities by building a new production facility; however, this effort was slow to progress, and LPC eventually sold its microlaser business unit to Melles Griot, Inc., a member of Barlow Scientific Group, Ltd. The sales agreement provided for initial payments for the purchase of most of the assets of LPC's microlaser operations and for future royalty payments of up to $2.7 million, based on sales of products that incorporate microlaser technology.

LPC's products allow Melles Griot to sell microlasers that offer 3 W of output power at 532 nm, shorter wavelengths at 457 nm, and a robust, solid-state technology. In addition, LPC's microlaser products were transferred to the Melles Griot Laser Group's new and wholly dedicated 100,000-square-foot laser-manufacturing facility in Carlsbad, California.

New Technology Benefits Many Industries

Proxima Corporation incorporated the microlaser technology into its display units. The company developed working prototypes of projector display units that incorporated the RGB microlaser technology. After further research, however, Proxima determined that it was not economically feasible to pursue commercialization initiatives. Proxima's studies revealed that, although the new technology was very effective in both brightness and resolution, competing products were more cost effective.

Although Proxima did not pursue this project beyond the development stage, the company gained a significant understanding of the new technology. This knowledge helped Proxima to apply the microlaser technology to other projection-display products, as well as in other technology areas that rely on modulated light information transmission. The primary benefit of this new technology to both directly and indirectly related applications was a significant increase in viewing resolution. In the projection market alone, some of the applications that benefited from the increase in resolution include:

- Helmet-mounted displays
- Virtual-reality viewers
- Flight simulators
- Advanced aircraft-cockpit displays
- Home entertainment systems
- Medical/surgical training aids

Although the initial objective to incorporate the RGB microlaser technology into high-resolution multimedia laser projection display units was not accomplished, a significant level of spillover was achieved in otherproducts and industries. Furthermore, the knowledge base resulting from this project continues to be valuable to both the companies involved and to others.

Conclusion

Although LPC sold its microlaser business unit to Melles Griot, the outlook for the RGB technology and its associated benefits is excellent. Melles Griot, with its strong revenue stream and solid customer base, is well positioned to further advance the RGB microlaser technology. Moreover, the United States is positioned to profit from this technology through its stronger presence in the microcrolaser projector and microlaser markets.

Although Proxima did not pursue commercialization of the high-resolution multimedia laser projection displays, the company gained a significant understanding of the new technology, which led to the granting of several patents. In June 2000, Proxima Corporation and Infocus Corporation completed a merger agreement. The new company kept the name InFocus Corporation and is now the world's largest developer, manufacturer, and marketer of multimedia projection systems and services.

PROJECT HIGHLIGHTS
Laser Power Corporation

Project Title: Commercializing Red-Green-Blue Microlaser Technology To Revolutionize Projection Displays (High-Resolution Multimedia Laser Projection Display)

Project: To research and develop methods of production for RGB laser technology to meet projected demands for large-area, HDTV, and multimedia displays.

Duration: 1/15/1995-1/14/1997
ATP Number: 94-01-0133

Funding (in thousands):

ATP Final Cost	$ 1,695	48%
Participant Final Cost	1,800	52%
Total	$ 3,495	

Accomplishments: Laser Power Corporation achieved several technical successes through its collaboration with ATP, including the following:

- LPC increased the blue microlaser's output power from 10 mW to greater than 750 mW.
- LPC increased the green microlaser's output power from 300 mW to 4.4 W.
- LPC continues to improve the red microlaser's output power along with the other microlasers.
- Furthermore, Proxima developed working prototypes of display units that incorporate the RGB microlaser technology.

LPC received the following patents for technologies resulting from this ATP project:

- "Efficient frequency - converted laser" (No. 5,761,227: filed December 5, 1996, granted June 2, 1998)
- "High resolution image projection system and method employing lasers" (No. 5,990,983: filed June 23, 1997, granted November 23, 1999)

Proxima received the following patent for technologies resulting from this project:

- "Laser illuminated image producing system and method of using same" (No. 5,704,700: filed July 24, 1995, granted January 6, 1998)

Commercialization Status: Melles Griot is continuing the research, development, and commercialization of red-green-blue microlaser technology. InFocus Corporation, the result of the merger between Proxima Corporation and InFocus Corporation, is now the world's largest developer, manufacturer, and marketer of multimedia projection systems and services. InFocus Corporation continues to benefit from the RGB microlaser technologies developed during the ATP project.

Although the original companies involved in developing this breakthrough technology are not actively pursuing the RGB microlaser display technology, they have benefited from this joint program. LPC, which was the lead participant in this project, sold its microlaser business unit to a company that could properly support the continuation of the technology. In addition to the undisclosed dollar amount for the sale of the unit, LPC arranged for $2.7 million in future royalty payments to aid in the company's expected technology research and development endeavors in its core competencies of optics and thin film coatings.

Outlook: The multimedia projection systems and services market is expected to grow substantially because of high demand. Therefore, the potential for diffusion of the ATP-funded technology through Melles Griot and InFocus Corporation is promising.

Composite Performance Score: * *

Number of Employees: Eighty-five employees at project start, 85 upon completion of status report

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