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ADVANCES IN OPTICS, ELECTRO-OPTICS, AND OPTOELECTRONICS

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COMMERCIAL TECHNOLOGY ACHIEVEMENT AWARD WINNERS

LightSaber takes the prize

The winner of the first annual *Laser Focus World* Application of the Year Award is the LightSaber, a Floptical laser servowriter designed by Iomega (Roy, UT). In the LightSaber, an acousto-optically controlled argon-ion laser etches more than 1,500,000 servo marks on a 3.5-in. Floptical disk. When used in a Floptical drive, these 3.5-in. disks can store 21 Mbytes of data. Conventional 3.5-in. floppy disks have a capacity of only 1.44 Mbytes. High-density storage is possible because the servo marks, or "stitches" as the company refers to them, are written at a density of 1245 tracks/in. (Conventional disks are written at 135 tracks/in.) A holographic optical element and a diode laser track the stitches for precise positioning.

IOMEGA CORP.

LightSabers' development team includes (from left) Fred Thomas, Don Wallentine, Jeff Heitzman, Paul Johnson, Robert Short, Jim Bero, and Eric Mitchell. George Krieger is missing from the photo.

According to Fred Thomas, electro-optic design engineer at Iomega, the company originally was planning only to manufacture Floptical drives. The development of the LightSaber came about as "brand-name" media manufacturers abandoned the idea of laser-etching Floptical disks in favor of stamping. George Krieger, then senior director of manufacturing at the company, saw an opportunity because Iomega had expertise in magnetic servo writing that he believed could shorten production time for a laser servowriting process. To be economically justifiable, the task required more than 1.5 million servo-control marks on each disk with a size and position tolerance of 0.2 µm, in a cycle time at least an order of magnitude faster than done before.

Krieger assembled a group of engineers in September 1991 to meet the challenge. Team leader Jim Bero came from Verbatim Corp. Other members included Thomas, Paul Johnson (responsible for mechanical and pneumatic design), Robert Short (code writer), Don Wallentine and Eric Mitchell (electronic design), and Jeff Heitzman (mechanical design). Working round the clock for four and a half months, they finished the proof of concept unit and successfully tested it in February 1992. The company sold the first LightSaber in May 1992, and it started manufacturing its own Floptical disks with LightSaber in August 1992. Thomas estimates that now 90% of Floptical media are manufactured with a LightSaber.

Design hurdles and trade-offs

Because of the 0.2-µm tolerance requirements, a highly stable laser beam was critical. Iomega selected an Innova laser from Coherent (Santa Clara, CA). This stringent tolerance translates to a beam-pointing stability of ±12 µrad. The system needed stable and high-bandwidth laser beam power control using acousto-optic (AO) attenuation. The designers needed to trade off obtaining the necessary high acousto-optical modulation bandwidth with a separate AO modulator and AO beam deflector against the simplicity of using a single AO modulator/deflector design. They figured out how to do it with a single AO device.

The depth of focus for etching needed to be maintained over the entire flexible media work piece, so the design team implemented a vision system to monitor the ablation spot size. Rapid submicron positioning was accomplished by including laser displacement Doppler meter feedback with a voice-coil-actuated linear air slide positioner. Another challenge was designing the optical alignment to withstand the rigors of three-shift manufacturing.

The LightSaber incorporates innovative electro-optical components and technologies. Precise etching with an argon-ion laser is noteworthy because these lasers are relatively mature products. It is fitting that they are an integral part of the first application to be honored with the designation "Application of the Year.

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