

PRIVATE COMPANY PROFILE:

LASER LIGHT ENGINES

NANO-DRIVEN NEXT GENERATION LASER LIGHTING

Research^{2.0}

Boston | New York | Paris

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CAPSULE

Inadequate brightness is a major obstacle for the cinema industry to overcome. Laser Light Engines is poised to deliver the **laser-based lighting technology that will usher in the next generation of digital and 3D projectors**. Not only will the quality of 3D cinema **improve dramatically** but the **economics will improve** as operating costs and energy bills for theater owners decline at the same time. IMAX is a strategic investor and will help lead the commercialization of the technology.

LIGHTING UP THE BIG SCREEN

Despite the shift to digital projection technology in theaters, we are still using old-fashioned giant light bulbs in the projectors for illumination and they are not bright enough. In addition, they are very expensive to operate, must be replaced 2-4x per year, and cost thousands of dollars. Some award-winning film producers have stated publicly they aren't interested in working with digital 3-D film because of the poor illumination from traditional technology.

Although laser-based light sources are known to be superior and have been tried in the past, the interference patterns generated by the light beams made the images unsuitable for viewing.

Laser Light Engines (LLE) has proprietary nano-enabled technology that has solved the interference pattern and produces the needed light colors in a simple and cost effective manner. Over time, it is likely that all digital and 3D theaters will convert to laser-based light sources.

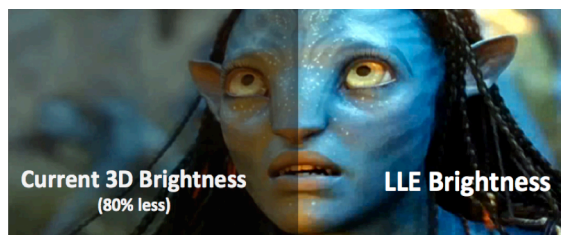
The market opportunity for LLE is aligned with the shift to digital and 3D cinema screens and starts at the high end with systems for IMAX (IMAX has made a strategic investment in LLE) and then moves into the mainstream. We estimate that LLE has a near-term \$1.2B market opportunity over the next four or five years with more beyond that as the technology becomes more commonplace.

LASERS ARE BETTER

The conversion to digital involves several different elements. The digital projector is similar to what many of us have encountered in conference rooms but with much more powerful optics and lighting inside. A large digital projector has a special Xenon-based lamp in it that is 15 times more powerful than those used in conference room projectors. Leading companies in the high-end digital projector market include Barco, Sony, Christie and NEC. Along with the projector, in many cases the screen is also upgraded, especially for 3D, with lower-light-loss surfaces or a silver coating to support polarized 3D methods.¹

Operational cost savings is another major reason to shift to laser-based light sources. The high-powered lamps used to drive projectors today generate lots of heat, have a relatively short operating life, begin to degrade immediately with use and are very expensive.

The ability to deliver higher brightness and cost savings is a powerful combination for high-end uses like IMAX, theme parks and larger 3D cinemas. In addition to the improvement in quality and viewer experience, the exhibitor can expect a 12 to 18 month payback period.



¹ For a more comprehensive treatment of this technology area please see: "[3D Computing from Digital Cinema to GPUs](#)" which we published with GigaOM Pro in October 2009.

Volume manufacturing will continue to lower costs and provide similar economics for the mainstream market and ultimately even offices, homes and a diverse range of small venues. Ironically, the “burn out” factor looms larger at the lower end of the market because most users in this category are loath to spend an extra \$500 on a spare bulb for a \$1,500 projector.

Bright hot white lights that burn out and cost hundreds or thousands of dollars will eventually go the way of the cathode ray tube (CRT) into oblivion.

TECHNOLOGY DISCUSSION

Using a laser-based light source is harder than it would seem. A major technical issue called “speckle” stems from the interference of light waves having the same frequency. This is exactly what happens when you try and use a laser light to project on a screen. When the light hits the surface of the screen it scatters with different phases and amplitudes. These add together to create a randomized intensity which results in an unpleasant “speckle” for viewers.

There are multiple ways to reduce speckle and some have been known for a long time. LLE has employed an array of techniques, some of which are patented, to achieve excellent results. LLE technology broadens the light spectrum and adjusts timing, polarization and beam angle all at the same time. Overcoming speckle was a necessary step but it’s not sufficient. For laser light sources to be effective they also have to be inexpensive enough to be easily justifiable. If laser light sources cost \$1m their advantages wouldn’t matter because few (if any) theaters would make the investment.

LLE has also innovated here to leverage lower cost core technologies, like diode laser pumps, and then uses nanotechnology to deliver highly scalable lighting with the red, green and blue outputs needed for full color imaging. This approach makes the initial LLE offering economic for high end screens like IMAX and will allow costs to come down rapidly with volume manufacturing to hit the price points needed for the broader market.

MARKET OPPORTUNITY

The market opportunity for LLE follows a classic technology diffusion model. The starting point will be

the high end very large format screens and then move to standard theaters; ultimately, we will see laser light sources in home and office projection equipment.

With IMAX as a strategic investor, LLE has a great partner to work with for the initial very high end systems that are needed for large format screens. These systems will carry higher prices in the low six figures. IMAX is expanding and believes that they can grow their current footprint of 528 theaters deployed (out of a total of 642 under contract) to over 1,200 during the next several years. It’s worth noting that in the March 2011 quarter IMAX installed more than double the number of theaters versus a year ago (43 versus 19) and signed contracts for 101 theater systems versus 41 signings in the March 2010 quarter. The company has commented that their accelerating momentum is likely to cause them to revise up their expectations regarding the total number of theaters they can have. IMAX alone is at least a \$100-200m

opportunity for LLE. (It’s not surprising IMAX wanted to make an investment in LLE.)

There’s more to the high end than IMAX, and companies like Disney are intensely interested in upgrading to laser-based light for their large format displays and content.

Using industry projections for digital/3D screens, there will be 100,000 in operation in 2014. If all these screens went LLE the market opportunity would be over \$2B. Taking a much more conservative view and looking at just the 3D screens, the market that LLE is operating in is worth just over \$500m in the next five years.

But our own market intelligence suggests that the industry figures are likely to go up, possibly as much as 50% for future years. The main reason for this is that these forecasts were put together based on industry activity in 2009 and 2010 when economic activity was below normal. Digital and 3D conversions continued through this period but have accelerated in 2011.

Using our own forecast for digital and 3D screen growth, by 2015 we expect 60,000 3D screens in operation which, at a \$20K ASP, puts our working total market opportunity for LLE at \$1.2B. Investors should realize that the ASP will be much higher in the early years and ultimately “blend down” to \$20-25K.

“The next generation of digital projection won’t be bulb-driven but laser-driven.” Rich Gelfond, CEO of IMAX at the March 2011 Gabelli Media Conference

Beyond 2015 LLE growth would be driven by industry capacity additions but could also be supplemented with lower-cost products that could penetrate new markets in the home, office and outdoor advertising. We have not yet taken the time to estimate the market opportunity for this segment as it may require a different business model approach, like licensing, which would make any analysis more or less pure conjecture at this point. It's certainly going to happen but the timing, price points, margins and business model are unknowable for now.

MANAGEMENT AND GROWTH STAGE

The management and board of LLE are comprised of industry experts including Doug Darrow, the CEO, who spent 23 years with Texas Instruments and was General Manager of their DLP Cinema division. The rest of the team members have extensive backgrounds in laser physics, fiber optics, engineering and growing start-ups into real companies. Bob Lambert, former SVP for worldwide technology strategy at Disney, serves on the board of directors.

Today LLE is focused on the first stage of commercializing their technology, which has resulted in initial orders, first stage manufacturing with deliveries, and revenue generation beginning in late 2011. The company is also laying the foundation for higher volume manufacturing in the future. LLE is categorized as an early stage investment by Harris & Harris, but it is clear from our analysis that the company is exiting the development stage and moving into expansion, with deliveries and rapid growth planned for the next 12-18 months.

While there could be an IPO in LLE's future, it is more likely an established company will acquire LLE. It's hard to know the expected total return to H&H if such an acquisition were to materialize. That said, we would expect the final transaction value of any deal to be above the current value H&H is carrying on their books, and thus enhancing to H&H's future NAV.

For more information about Laser Light Engines, the digital cinema industry or Research 2.0 please get in touch with us:

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RELATED PUBLIC COMPANIES

SELECTED PUBLIC COMPANY DESCRIPTIONS²

IMAX

IMAX Corporation, together with its subsidiaries, operates as an entertainment technology company world-wide. It specializes in digital and film-based motion picture technologies. The company operates in eight segments: IMAX Systems, Theater System Maintenance, Joint Revenue Sharing Arrangements, Film Production and IMAX DMR, Film Distribution, Film Post-Production, Theater Operations, and Other. The IMAX Systems segment designs, manufactures, sells, or leases IMAX theater projection system equipment. The Theater System Maintenance segment maintains IMAX theater projection system equipment in the IMAX theater network. The Joint Revenue Sharing Arrangements segment provides IMAX theater projection system equipment to an exhibitor in exchange for a share of the box-office and concession revenues. The Film Production and IMAX DMR segment produces films and performs film re-mastering services. The Film Distribution segment distributes films for which the company has distribution rights. The Film Post-Production segment provides film post-production and film print services. The Theater Operations segment owns and operates IMAX theaters. The Other segment engages in camera rental business, as well as offers after market sales services for projection system parts and 3D glasses. The company serves institutional customers, such as science and natural history museums, zoos, aquaria, and other educational and cultural centers, as well as commercial multiplex exhibitors. It also sells or leases its theater systems to theme parks, tourist destination sites, fairs, and expositions. As of December 31, 2010, the company's IMAX theater network comprised 518 theater systems, including 396 commercial and 122 institutional systems. IMAX Corporation was founded in 1967 and is headquartered in Mississauga, Canada.

REALD

RealD Inc. licenses stereoscopic three-dimensional or 3D technologies internationally. The company licenses its RealD Cinema Systems to motion picture exhibitors that show 3D motion pictures and alternative 3D content. It also provides RealD Format, active and passive eyewear, and display and gaming technologies to consumer electronics manufacturers, content producers and distributors to enable the delivery and viewing of 3D content on high definition televisions, laptops, and other displays. The company's 3D technologies also have applications in piloting the Mars Rover, heads-up displays for military jets, and robotic medical procedures. It develops and supplies 3D visualization tools for science, research, and product development. RealD Inc. has a strategic alliance with Sonic Solutions. The company was founded in 2003 and is headquartered in Beverly Hills, California.

CINEDIGM

Cinedigm Digital Cinema Corp. provides technology solutions, financial services and advice, software services, electronic delivery, and content distribution services to owners and distributors of digital content to movie theatres and other venues. Its Phase I Deployment and Phase II Deployment segments engage in the ownership and licensing of digital systems to theatrical exhibitors. The company's Services segment provides monitoring, billing, collection, verification, and other management services to the company's Phase I Deployment and Phase II Deployment, as well as to exhibitors, who purchase their own equipment. It also develops and licenses software to the theatrical distribution and exhibition industries, and provides applications service provider service, software enhancements and consulting services. In addition, this segment distributes movie features, trailers, and other alternative content to movie theaters and other venues with digital cinema equipment via satellite and hard drives, and provides non-theatrical satellite based distribution of content into various out-of-home networks and other channels. Its Content & Entertainment segment provides content marketing and dis-

² Company descriptions provided by CapitalIQ.

tribution services to alternative and theatrical content owners, as well as to theatrical exhibitors, and in-theatre advertising services. The company was formerly known as Access Integrated Technologies, Inc. and changed its name to Cinedigm Digital Cinema Corp. in October 2009. Cinedigm Digital Cinema Corp. was founded in 2000 and is based in Morristown, New Jersey.

BARCO

Barco NV designs and develops visualization solutions for professional markets worldwide. It offers hardware and software solutions integrating various aspects of the imaging chain from image acquisition and processing to image display and management. The company provides display monitors, such as air traffic management, avionics, widescreen LCD, medical, reference, and rugged displays, as well as mobile point of care devices; projectors, including digital cinema, event venue, fixed install presentation, simulation and training, and stereoscopic projectors, as well as rear projection systems; and multi projector displays comprising rear projection video walls, simulation and training display systems, and stereoscopic display systems. It also offers lighting products, which consist of digital lights, automated luminaries, led luminaries, lighting controllers, and media servers; LED solutions, such as creative modules, integrated solutions, and modular tiles; and image processing solutions, including encoders and decoders, JPEG 2000 solutions, LED display digitizers, matrix switchers, multi-format signal processors, presentation systems, scalable desktop solutions, and video wall controllers. In addition, the company provides sensors and sensor processing solutions; servers and workstations comprising air traffic management display servers, avionics computers, command and control workstations, rack/console mount workstations, and media servers. Further, it provides air traffic management software, avionics applications, control room software, display management software, and broadcast monitoring and remote desktop solutions; and electronic design services and medical solutions for original equipment manufacturers. The company serves medical imaging, media and entertainment, infrastructure and utilities, traffic and transportation, defense and security, and education and training markets. Barco NV was founded in 1934 and is headquartered in Kortrijk, Belgium.

DOLBY

Dolby Laboratories, Inc. develops and delivers products and technologies for the entertainment industry worldwide. It designs and manufactures video and audio products for film production, cinema, and television broadcast industries. The company is involved in licensing technologies in signal processing systems that enhance sound quality or enable surround sound in movie soundtracks, DVDs, Blu-ray Discs, personal computers, digital televisions, mobile devices, video games, and satellite and cable broadcasts; and developing technologies for mobile devices, digital 3D, digital cinema, post-production, and LED backlit LCD televisions. It also offers traditional cinema processors, which are used to read, decode, and play back a film's soundtrack and calibrate the sound system in a movie theater; digital cinema products for digital cinema encoding, distribution, and playback; digital 3D products that deliver a 3D image with an existing digital cinema server and white screen; and digital media adapters to adapt analog cinema audio systems to the digital audio technologies. In addition, Dolby Laboratories provides broadcast products to encode, transmit, and decode multiple channels of audio for DTV and HDTV program production and broadcast distribution, and to measure the subjective loudness of audio content within broadcast programming; and professional reference monitor, a video monitor used in the production and post-production of cinematic and video content. The company licenses its technologies to media software vendors, such as operating system vendors, independent software vendors, and integrated circuit manufacturers; and manufacturers of home audio and video products, set top boxes, video game consoles, mobile devices, in-car entertainment systems, and PC manufacturers. It sells its products directly to customers, as well as through dealers and distributors. The company was founded in 1965 and is based in San Francisco, California.

TECHNICOLOR

Technicolor SA provides a range of video technologies, systems, finished products, and services to the media and entertainment industry. Its Entertainment Services segment offers video-related content management services; content preparation and creation; and content distribution services through physical media, including theatrical and DVD, and digital cinema production services, as well as through digital media, including digital

content delivery services. This segment also engages in the printing and distribution of film reels and DVDs for content producers/owners; provides tape and digital media asset management, production and postproduction, and broadcast playout services; provides broadcast services; provides electronic distribution services, such as digital video download support, live streaming, and disc initiated services, as well as solutions for the electronic distribution of music, software, and games; and manufactures and distributes video and game DVDs, Blu-ray discs, and CDs. The company's Connect segment supplies hardware and software technology in the areas of access and delivery platforms. It offers digital home products, including access and home networking products, set-top boxes, modems, and advanced service gateways, primarily to satellite, cable network, and telecom operators; connect devices, such as WiFi tablets; and a software service platform, which comprise softswitch solutions for network operators and Internet service providers. Its Technology segment provides corporate research and licensing services. The company offers its products in the United States, the United Kingdom, France, rest of Europe, and the Asia/Pacific. Technicolor was formerly known as Thomson and changed its name to Technicolor SA in January 2010. The company was founded in 1982 and is headquartered in Issy-les-Moulineaux, France.

BALLANTYNE STRONG

Ballantyne Strong, Inc. designs, develops, manufactures, services, and distributes theatre and lighting systems. The company operates in two segments, Theatre and Lighting. The Theatre segment offers digital equipment, such as cinema projectors, and motion picture projection equipment comprising motion picture projectors, xenon lamphouses and power supplies; a console system combining a lamphouse and power supply into a single cabinet, and soundhead reproducers, as well as related products, such as sound systems. This segment also provides film handling equipment, cinema screens, replacement parts, and digital and film projection lenses; it also offers cinema services, including film and digital projector maintenance, repair, installation, and site survey services. This segment sells its products directly to end users and to theatre exhibitors through a network of dealers. The Lighting segment offers followspots, promotional searchlights and lighting systems for the motion picture production, television, live entertainment, theme park, and architectural markets, and LED products. This segment sells its lighting products directly, as well as through commissioned representatives to arenas, stadiums, theme parks, theatres, auditoriums, and equipment rental companies. Ballantyne Strong, Inc. markets its commercial motion picture projection equipment under the Strong and Simplex trademarks; followspot products under the Strong, Super Trouper, and Gladiator trademarks; high intensity promotional searchlights under the Sky-Tracker and Strong Britelight trademarks; and LED products under the Lititude brand name. It offers its products and services primarily in the United States, Canada, China, the rest of Asia, Mexico, South America, and Europe. The company was formerly known as Ballantyne of Omaha, Inc. and changed its name to Ballantyne Strong, Inc. in June 2009. Ballantyne Strong was founded in 1932 and is headquartered in Omaha, Nebraska.

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