

# Ultraportable Projection Systems

**Matthew Brennesholtz**

**3/10/09**

## **Webinar to last 30 minutes—plus Q&A**

- **Introduction to Insight Media**
- **Ultraportable projector categories and markets (>50 lumens, not picoprojectors)**
- **Technologies for ultraportable projectors**
  - **Take a close look at illumination technologies**
  - **Details on other technologies in report**
- **Forecasts**
- **Conclusions**

## **Focus on emerging parts of the display industry**

- LED/Laser displays and applications
- 3D displays and applications
- E-paper displays and applications
- Green displays and regulations
- >1080p displays and related technologies

## **Insight Media Products**

- Daily and Monthly Newsletters
- Reports covering display technology and markets
- Consulting services
- Annual Conferences

- 2009 Ultraportable Projectors
- 2009 Low-Cost and Toy Projectors
- 2008 Pico-Projector Market Segment Analysis (update in April)
- 2008 LED Projection Systems Report
- 2009 E-Paper Displays, Applications and the E-Book Reader Market
- 2009 3D Gaming (May)
- 2009 Professional 3D Autostereoscopic Displays
- 2008 3D Television Report (update in May)



## 2009 LED- and Laser-based Ultraportable Projectors

*Technology, market, strategy and forecast analysis of low-lumen (>50 lumen) projectors (pocket and higher lumen projectors) targeted primarily at mobile applications.*

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**Chris Chinnock**

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- Many more—See website



**Dell M109S 50 Lm.**  
**0.36Kg \$499 DLP**



**Dell M209X 2000Lm.**  
**1.2Kg \$799 DLP**

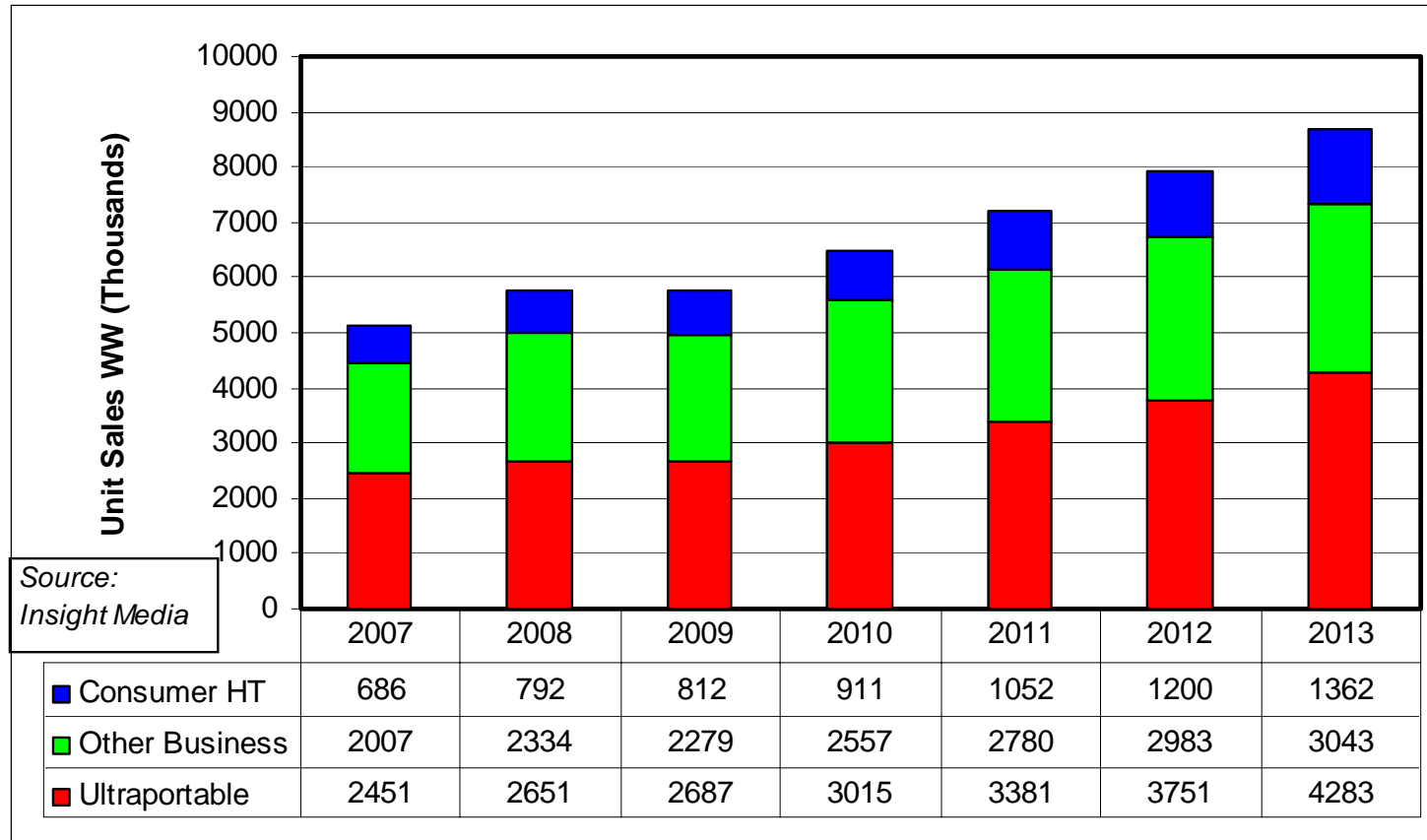


**LG HS102 160 Lm.**  
**0.77 Kg \$559 DLP**

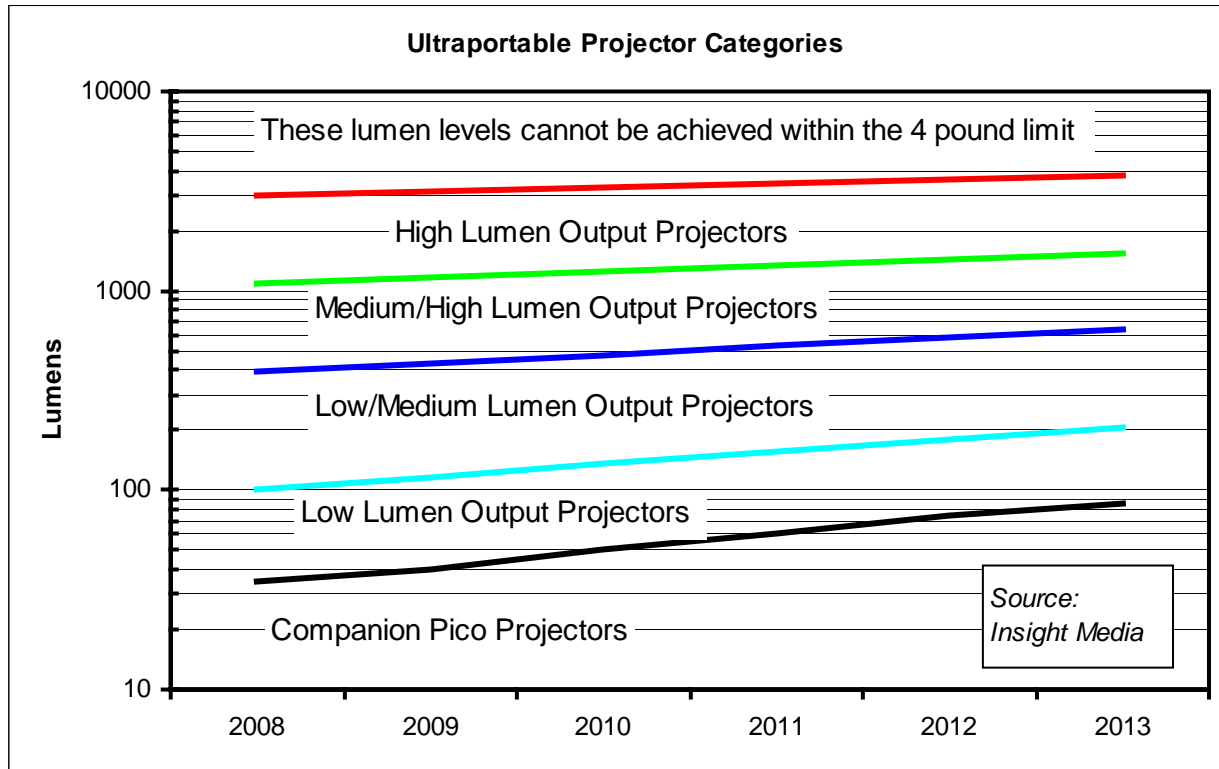


**Epson EB-1725 3000Lm.**  
**1.8Kg £1,135 (\$1,598)**

- **Under about 4 Pounds**
  - Some projectors as heavy as 6+ pounds are marketed as “Ultraportable”
- **Divided by Insight Media into 4 sub-categories**
  - Based on lumen output
  - All >50 lumens



- **Growth in 2009 stops because of recession**
- **Ultraportables consistently about 47% of sales**
- **This forecast does not include picoprojectors**



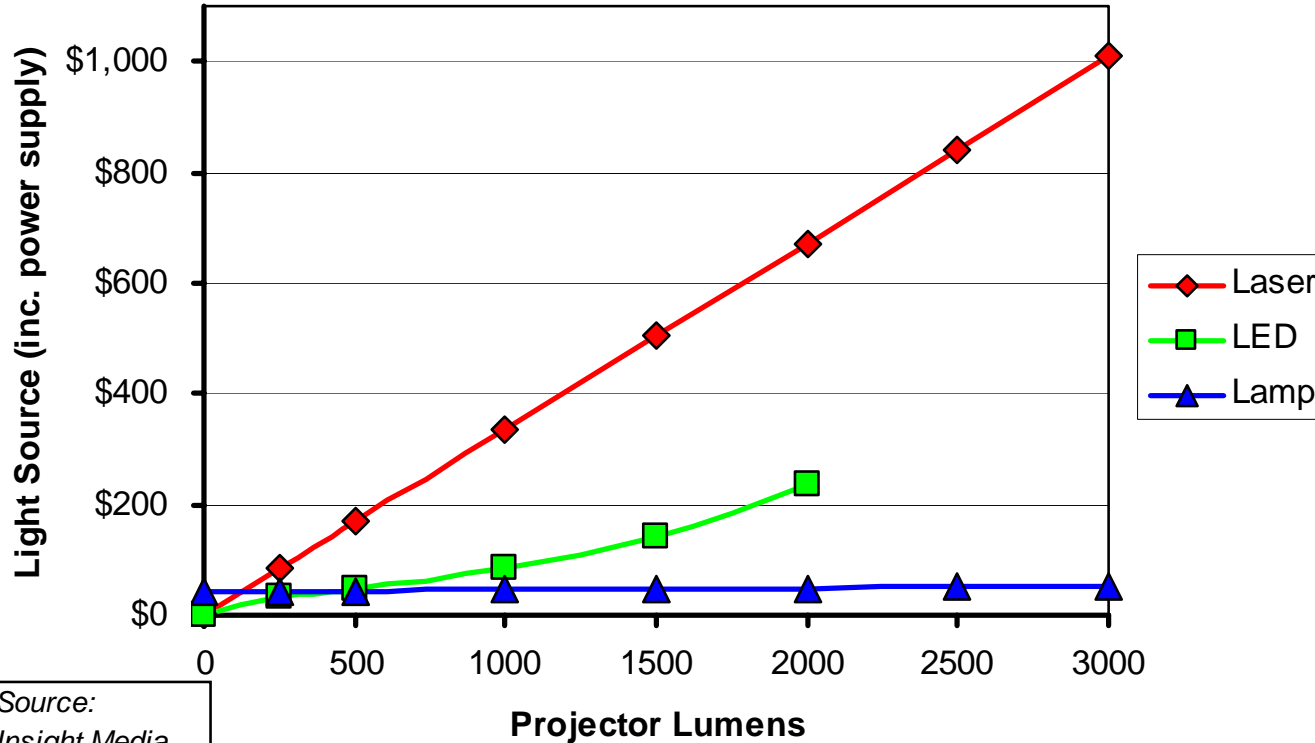
- **Four categories based on lumen output**
  - High output (conventional lamp-based UPs)
  - Medium/High output
  - Low/Medium output
  - Low output (pocket projectors)
  - Still lower output classed as picoprojectors and covered in the picoprojector report

- **Lamps**
  - Currently used in most ultraportable projectors
  - Projectors from 1400 Lm. to >2000 Lm.
- **LEDs**
  - Currently used in reduced lumen output projectors
  - Small projector size to enhance portability
- **Lasers**
  - Not currently used in ultraportable projectors
  - Supply chain is developing slowly

**Table 2: Illumination Technologies Suited for Various Projector Categories**

Category	LED	Laser	Ujoy	UHP	Example	Comment
Low	X	X			Dell M109S	Battery powered
Low/Medium	X	X	X		LG, Samsung, Lenovo, etc.	Battery/Wall power
Medium/High	X	X		X	None Current	Wall
High		X		X	100's of projectors	Wall

## Light Source Cost

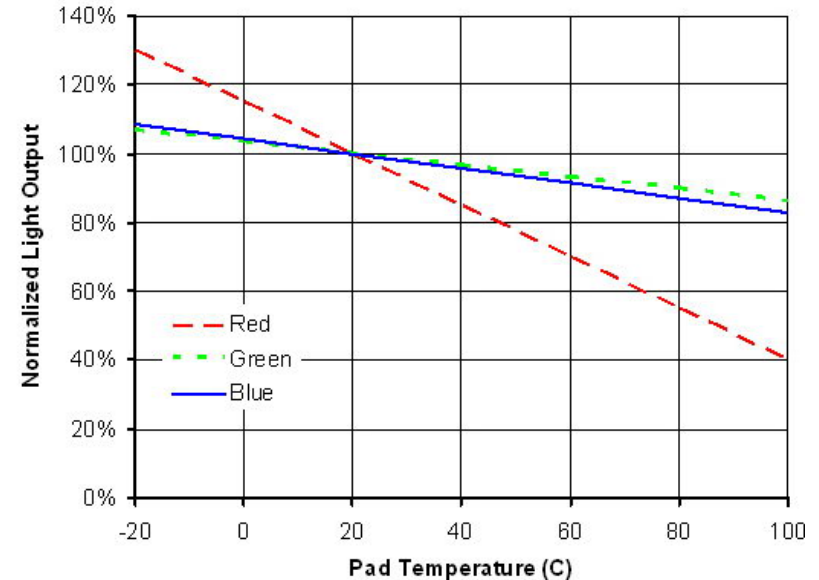
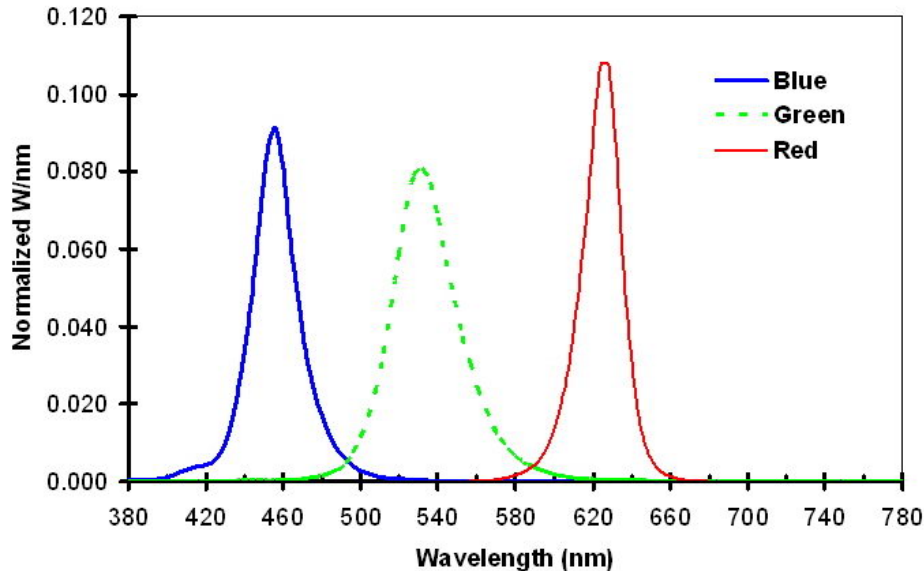


Source:  
Insight Media

*Cost calculated with the Insight Media ultraportable cost & performance model for a projector with a 1080p, 0.89" DLP in 2012*

*(Except for LED, cost of light source is nearly independent of imager size)*

- Lamp/ballast cost nearly independent of lumen output
- Laser cost is (will be) linear with output
- LEDs cannot be used in projectors with more than about 2000 lumens for the foreseeable future



## • LED Advantages

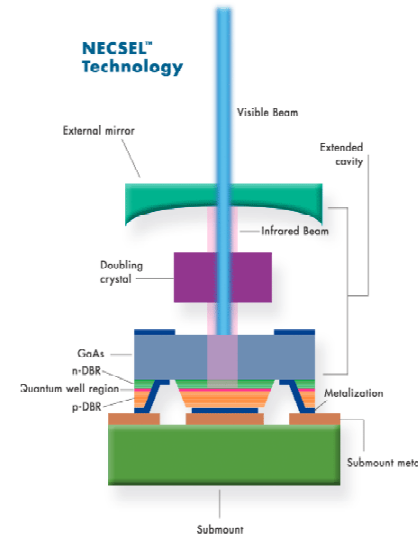
- Long lifetime
- Work well with DLP and other color sequential displays
- good colorimetry
- Mercury-free
- Simple drive circuits (unless maximum performance is required)

## • LED Problems

- High étendue
- Sensitive to changing temperatures
- Cost

*Most LED information is in the LED report. The ultraportable report applies this information to projectors under 4 pounds*

Osram Blue Laser in TO-38 Package



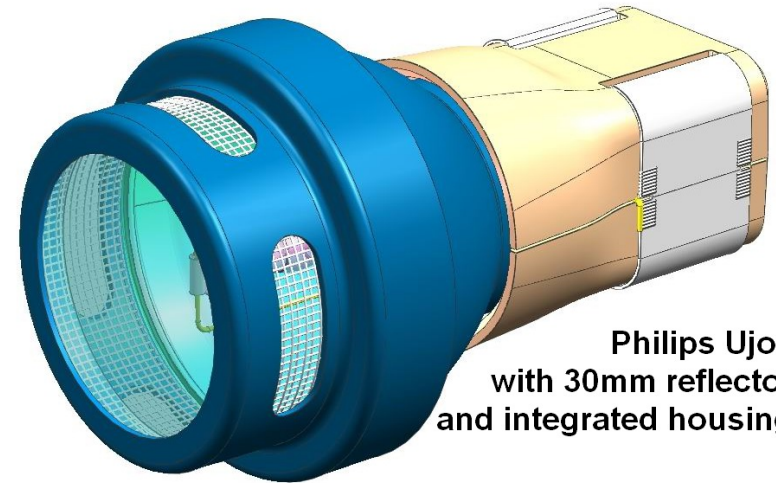
- **Laser Advantages**

- Long lifetime
- Work well with DLP and other color sequential displays
- Very low étendue
- Very good colorimetry
- Mercury-free

- **Laser Problems**

- Cost (!!)
- Availability
- Safety
- Speckle

*Most Laser information is in the Laser report.  
The ultraportable report applies this information  
to projectors under 4 pounds*



Philips Ujoy  
with 30mm reflector  
and integrated housing

- **Lamps Advantages**

- Very low cost
- Low étendue
- Acceptable colorimetry
- Good for high-brightness systems

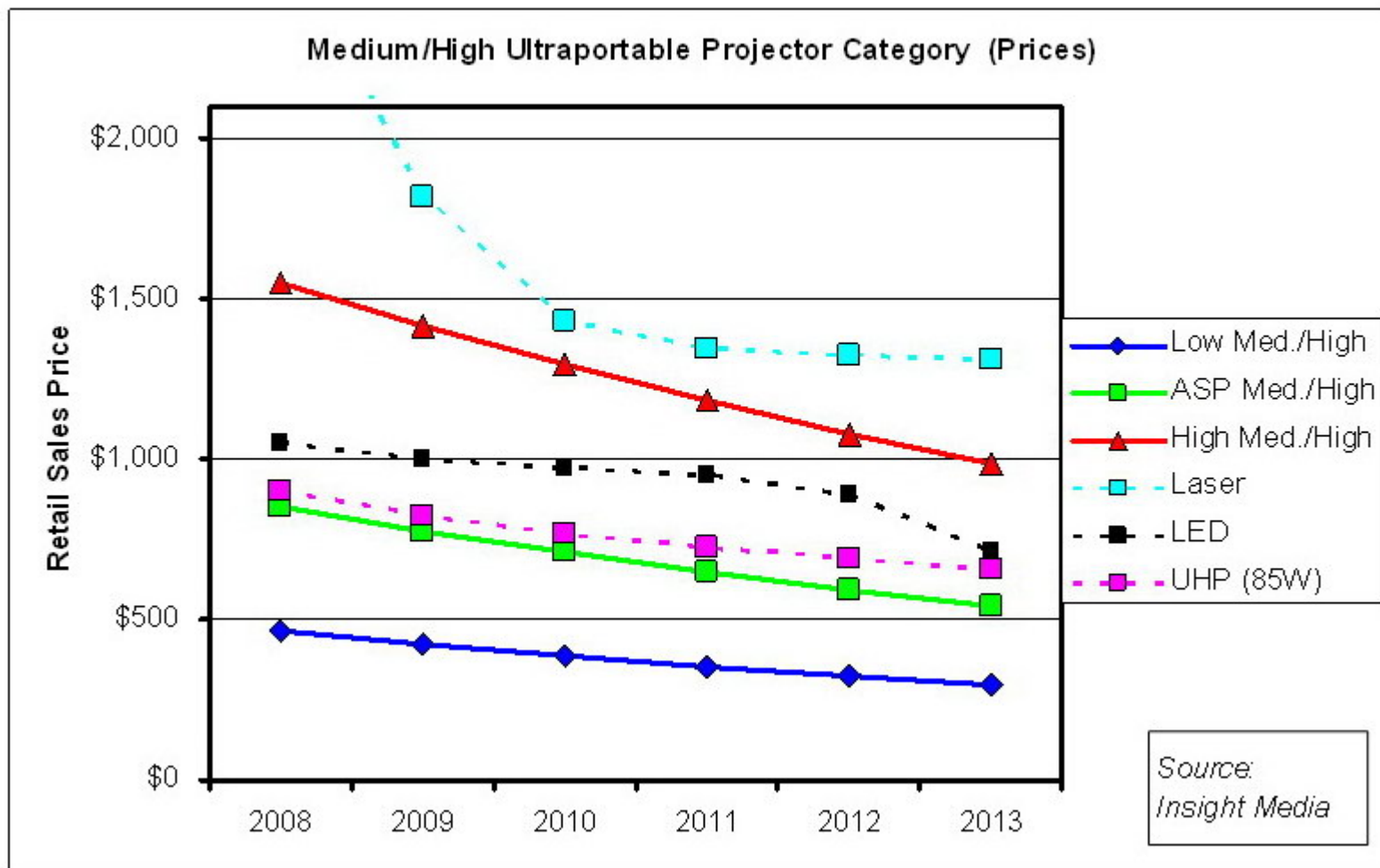
- **Lamps Problems**

- Limited lifetime
- Contain mercury
- High ignition voltages
- Difficult to build in low powers

- **Technology topics**
  - Microdisplay technologies suited for various projector categories
    - DLP, 3LCD and LCoS
  - Battery technology and prices for use in battery-powered projectors.
    - With forecasts on battery cost & weight through 2013
- **Markets**
  - Sales prices for ultraportable projectors
  - Ultraportable projector system BOMs and performance levels
  - Projector roadmaps going forward for various target markets
  - Sales forecasts (Unit sales and revenue)

- **Prices expected to decline going forward**
- **Largest price declines will be in the reduced-lumen categories**
  - **\$500 price for a 50 lumen projector is not sustainable**
- **Each projector category actually has a range of prices**

Figure 62: Price Range for Medium/High Ultraportable Projectors



- **Developed at Insight Media to estimate projector BOMs**
- **Used to estimate all major technology combinations**
- **Macros allow evaluating multiple version of each technology combination**
  - **Power levels**
  - **Pixel size**

**Table 45: BOM for WXGA 35W LED DLP Projector**

	Resolution	Technology	Light	Power	Pixel Pitch	f/#	BOM Multiplier	Battery Time
	Table	DLP	Table	Table	Table	2.0	2.5	2
	Tier=	Second	Luminus	0.0%	0.0%	0%	0%	
	Resolution Table		WXGA	WXGA	WXGA	WXGA	WXGA	
	Pixel Pitch Table		7.5	7.5	7.5	7.5	7.5	
	Power Table		35	35	35	35	35	
	Light Table		LED	LED	LED	LED	LED	
	Volume (K/mo)		10	10	10	10	10	
3LCD only		Microlens	Free	Free	Free	Free	Free	
DLP Package	Table		Low	Low	Low	Low	Low	
<b>Cost &amp; throughput Summary</b>			<b>DLP with LED</b>					
			<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>CAGR</b>
Sales Volume (K units per month)			10K	10K	10K	10K	10K	
Panel			WXGA	WXGA	WXGA	WXGA	WXGA	
Light Source			LED	LED	LED	LED	LED	
Pixel Pitch (Microns)			7.5	7.5	7.5	7.5	7.5	
Panel Diagonal (inches)			0.44	0.44	0.44	0.44	0.44	0%
Projection Lens f/#			2.00	2.00	2.00	2.00	2.00	0%
Power to light source			27.1	27.1	27.1	27.1	27.1	0%
Total projector power			35.0	35.0	35.0	35.0	35.0	0%
Estimated output (Lumens at Screen)			<b>117</b>	<b>159</b>	<b>215</b>	<b>288</b>	<b>366</b>	33%
Lumens/watt (total power)			3.3	4.5	6.1	8.2	10.5	33%
Microdisplay & ASIC (if needed)			\$78	\$68	\$61	\$55	\$51	-10%
Light source cost (including ballast/driver)			\$50	\$45	\$41	\$39	\$38	-6%
Other optical components			\$37	\$35	\$33	\$32	\$31	-4%
Other Components			\$66	\$63	\$61	\$59	\$57	-3%
Total Projector BOM Cost			<b>\$231</b>	<b>\$211</b>	<b>\$197</b>	<b>\$185</b>	<b>\$178</b>	-6%
BOM Multiplier			2.50	2.50	2.50	2.50	2.50	0%
Street Price			<b>\$578</b>	<b>\$528</b>	<b>\$493</b>	<b>\$463</b>	<b>\$445</b>	-6%
\$/Lumen			\$4.96	\$3.32	\$2.29	\$1.61	\$1.22	-30%
Battery Cost (Unit street price)			\$90	\$72	\$59	\$48	\$40	-19%
Battery Weight (g)			432	348	283	231	190	-19%
Street Price Including Battery			<b>\$668</b>	<b>\$600</b>	<b>\$552</b>	<b>\$511</b>	<b>\$485</b>	-8%

- BOM was produced by Insight Media Cost/performance model
- Can model all UP technology combinations:
  - Light source
  - Microdisplay type
  - Power level
- Yellow highlights indicate model inputs

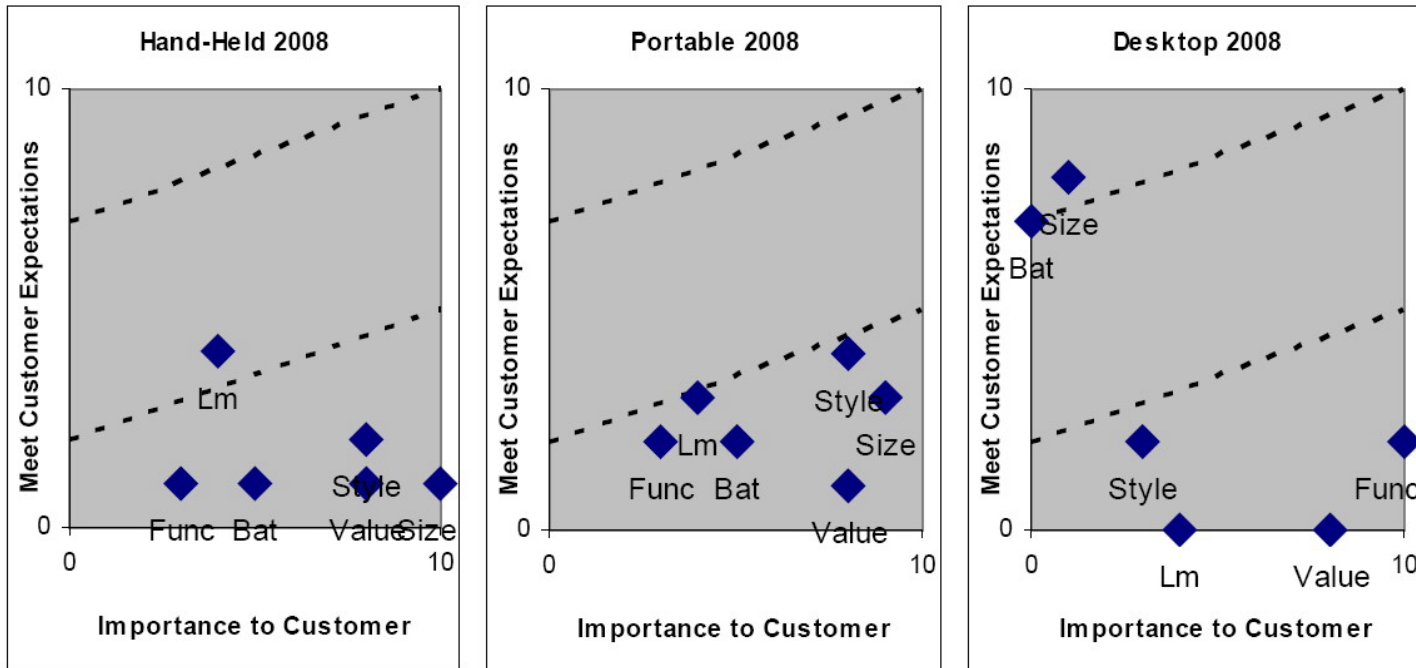
# Sample UP Roadmap

**Table 27: Anticipated Roadmap for 100-Lumen Projectors**

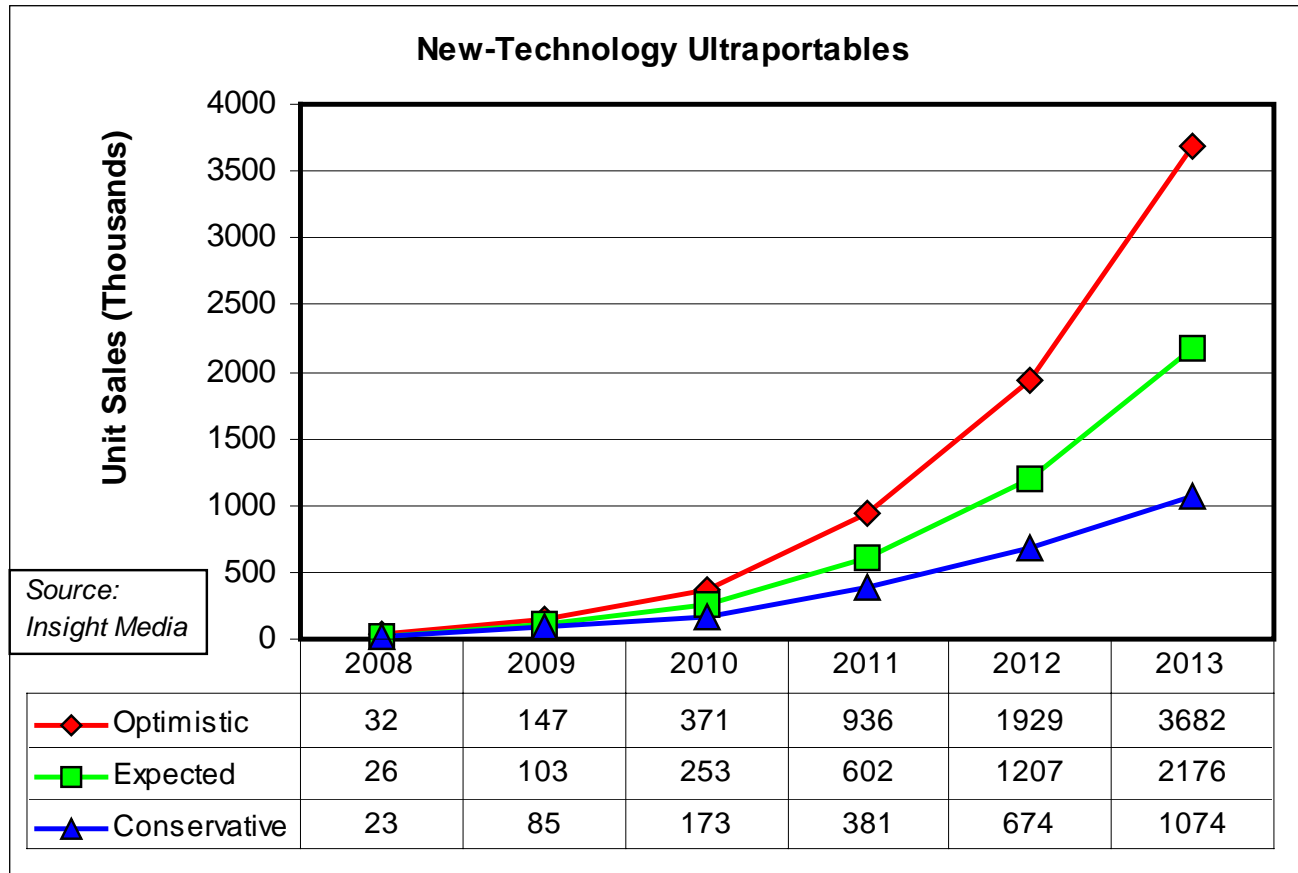
		2008	2009	2010	2011	2012
\$80-100 BOM	Resolution Source Battery Price				SVGA/WSVGA Laser/LED \$14-23	SVGA/WSVGA Laser/LED \$11-16
\$101-120 BOM	Resolution Source Battery Price			SVGA/WSVGA LED \$25-53	WSVGA/WXGA Laser/LED \$11-22	WSVGA/WXGA Laser/LED \$11-15
\$121-140 BOM	Resolution Source Battery Price		SVGA/WSVGA LED \$49-55	WSVGA/WXGA LED \$25-38	WSVGA/WXGA Laser \$11-14	
\$141-160 BOM	Resolution Source Battery Price	SVGA LED \$81	SVGA/WSVGA Laser/LED \$22-70	WSVGA/WXGA Laser/LED \$16-33	WXGA LED/Laser \$14-21	
\$161-180 BOM	Resolution Source Battery Price	SVGA/WSVGA LED \$81-82	WSVGA/WXGA Laser/LED \$22-53			
\$181-200 BOM	Resolution Source Battery Price	WSVGA/WXGA LED \$81-94				

- **Historical penetration rates of new products examined**
  - High (10) corresponds to very successful product like cell phone camera
  - CE (8) corresponds to typical consumer electronic
  - Slow (2) corresponds to product with poor initial acceptance such as portable navigation device
  - None (0) corresponds to a product that is a complete failure

**Figure 74: Low Lumen Projectors with LED Illumination Evaluation (2008)**

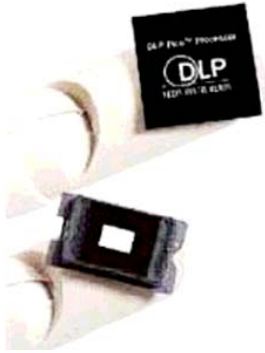
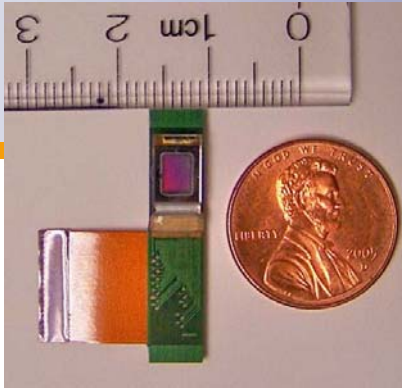


- **Projectors evaluated for multiple properties**
  - 10 technology combinations, 3 user groups for each combination
  - 6 properties evaluated for importance and ability to meet needs for each combination
- **Ranking determined expected penetration level and Year 1 (product introduction)**



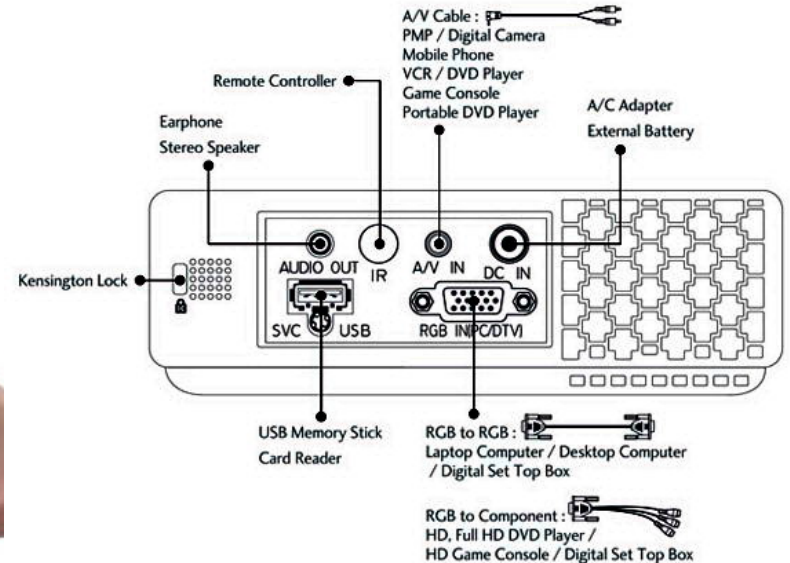
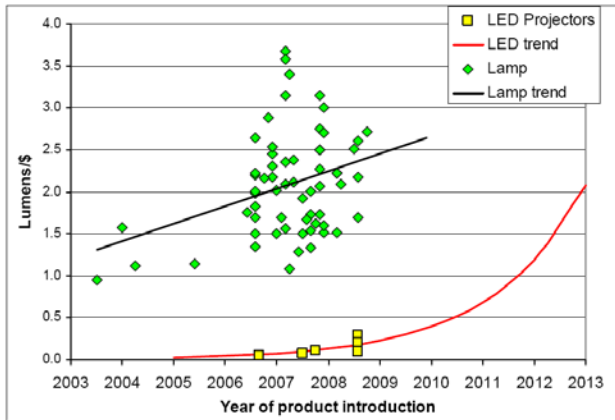
- Includes LED, Laser and Ujoy projectors (Including Ujoy follow-on lamps)
- Ultraportable report breaks this down by lumen category and light source
- Some sales represent cannibalization of conventional UHP-type lamp-based ultraportable sales, some are new sales (see report for details)

- **Lamp-based ultraportable projectors provide a very good value proposition**
- **LED-based ultraportable projectors must be marketed on the strengths of LEDs**
  - They cannot compete with lamps on price or lumen output
  - Other properties of LEDs will allow increasing penetration into the market
- **Lasers not yet ready for ultraportable market**
  - A few projectors may be available at high prices in 2010
  - Significant penetration in 2011 and beyond
  - Will be higher priced than lamp-based projector with the same output



# Questions?

Figure 35: LED- and Lamp-Based Projectors Compared



# Special Offer for Webinar Attendees!

2009 LED- and Laser-based Ultraportable Projector Report

Regular price: \$2950.00 USD

- 10% discount on complete report

OR

- Bundled with 2008 LED Projection Systems Report  
Normally \$4500.00

- 10% Discount on Bundle

**SEE TABLE OF CONTENTS AT:**

<http://www.insightmedia.info/reports/2009ledtoc.php>

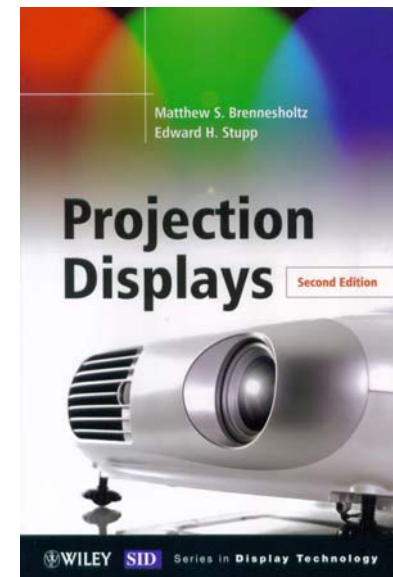
<http://www.insightmedia.info/reports/2008ledstoc.php>

*Special pricing not available on website.*

**To order, contact Insight Media:**

**Dian Mecca (203) 831-8464, [dian@insightmedia.info](mailto:dian@insightmedia.info)**

- **Projection and Direct-view Display Expert**
  - Over 31 years in a variety of roles in the display industry, including Manufacturing, Design, R&D, Sales and Marketing
  - Lead author of [“Projection Displays” 2<sup>nd</sup> Edition](#) from John Wiley & Sons
  - Holds 23 US patents
  - Numerous published articles and conference presentations at the SID, SPIE and other venues
  - Marketing reports on a variety of display topics while at Insight Media
- **Attended Cornell University where he received BS & M. Eng. Degrees in Engineering Physics**



- **Q: what technology do you expect to be used for high lumen LED projectors: 1DLP, 3DLP, 3LCD or 3LCOS?**
  - I see 1DLP, 3LCD and 1LCoS to be the dominant technologies. 3DLP and 3LCoS are too expensive for mass-market applications although there may be some special purpose LED projectors with these designs
- **Q: Are any of the LEDs narrow band? Say a few nm or tens of nm?**
  - All current LEDs are broadband with bandwidths in the 25nm – 40nm range depending on color, materials and design
- **Q: What kinds of laser power are you expecting, and when?**
  - Even today, lasers of arbitrarily high power are available, including lasers bright enough for 15k – 30k lumen projectors. Price is another issue. As I show in slide 9, lasers have a price disadvantage in high output applications compared to lamps.
- **Q: How much laser power do you need for a 1000 lumen projector?**
  - A 1000 lumen projector has 3 – 4 watts of optical power coming out of the projection lens. Assuming 50% efficiency, the total of the 3 colors of lasers needs to be about 6 – 8 watts.

- **Q: When the home projector will pick up the LED light source?**
  - Home theater projectors with about 700 – 1000 lumens will be available this year—at very high prices. For example the Delta 1080p DLP home theater projector with LEDs and 700 lumens is expected to retail for about \$19,995.
- **Q: See info on 100-lumen projector BenQ GP1, Acer K10, and Toshiba TDP-F10U, however they do not seem to appear on their company websites, it seems they are not readily available (are these projectors concepts or prototypes or are they shipping in volume??)**
  - All of these projectors are production prototypes, not laboratory demonstrations, as far as we know. Most LED-based projectors have been late compared to the introduction dates promised when the projector was first shown.
- **Q: Will the 50 lumen projector be squeezed by pico at the low end versus 100 lumen at the low/medium category**
  - Our expectation is that as technology improves the lower-limit of the low lumen category will increase to about 85 lumens by 2013, and continue to increase after that. This is based on two factors:
    - Improved performance of companion picoprojectors allowing them to achieve up to 85 lumens.
    - Pressure from customers for higher lumen outputs to allow more versatile use of these projectors.
  - It is possible the low lumen category will be squeezed out completely between the companion projectors and the low-medium category.

- **Q: The BOM Multiplier is 2.5 (is there a itemized list of the various component of the 2.5 BOM multipliers; for example: of how of the BOM might apply to packaging or assembly of 1.9 to 2.0**
  - The ultraportable report does not give this breakdown. Overall multipliers between 1.9 and 4.0 are seen in the current projector market. Distribution chain is the biggest determinant of the multiplier. 2.5 is a good number for the distribution chains used by ultraportable projectors.
- **Q: You say lamps are very low cost yet the cost to the end consumer is \$200-\$300 for a replacement lamp. How do you define that as low cost?**
  - Lamp plus ballast costs the OEM \$40 - \$60 in volume. The \$200 - \$300 is the retail price of a single lamp with not only the lamp but with the housing. There are hundreds of these lamp/housing combinations so each one is sold in very low volume and the lamp distributor needs to have a very large stock since end users don't want to wait for a lamp delivery. The Ujoy lamp, with no housing required, is expected to simplify this supply chain.
- **Q: How do you view the discussion that ANSI lumen measurements, used today for bulbs, are not appropriate for LED projectors?**
  - Lumen output (ANSI or otherwise) is believed to understate perceived brightness when a projector has highly saturated primary colors, such as projectors with LED or laser light sources. This topic needs considerably more research, however.
- **Q: What is the difference between pico and ultra portable?**
  - Companion pico projectors are small, can fit in your pocket, and (eventually) will be battery powered. Low-lumen ultraportable projectors have higher output and a larger form factor. Today, Insight Media puts a 50 lumen threshold, increasing to 85 lumens in 2013

- **Q: What commercial applications are driving the UP market now (as opposed to future markets)?**
  - Ultraportable projectors were designed around portable applications such as the Road Warrior. Due to the very good value proposition of lamp-based ultraportables, many are sold into applications such as small conference rooms where portability is a secondary factor.
- **Q: what is target price for Laser ?**
  - The Insight Media laser report provides two forecasts for lasers for projectors. The first is an extrapolation of the prices of currently available lasers and sets an upper limit on laser prices. The second forecast is called the “Breakthrough Forecast” and is based on the expected prices of lasers specifically designed for high volume applications such as displays. This is not a simple extrapolation of current prices because these lasers need special designs optimized for high volume manufacturing. This breakthrough forecast was used when estimating laser prices in the Ultraportable Report. See the Insight Media Laser report for details on both of these forecasts
- **Q: do you see 3D capability being standard for movies and games**
  - 3D capability can be added to most displays at a very small incremental cost. Insight Media estimates there are about 2 million 3D-ready TV sets in the US today. Many of the owners are not even aware their TVs are 3D capable. When the killer App comes along, these numbers can ramp up rapidly. Games is seen as one of the killer apps, perhaps even more than movies.
- **Q: What size microdisplay were you considering for the BOM rollup showed earlier?**
  - The BOM on slide 17 uses a WXGA DLP with a 7.5 micron pitch, giving a 0.44” diagonal. This is not a current product at TI but could be built if TI sees enough demand for it.

- **Q: are 50 lumen pocket projectors viable or do you really need 100 or 150 lumens**
  - For some applications, 50 lumens is enough. For other applications, the small size of a 50 lumen projector outweighs the low lumen output. It all depends on what the consumer and business buyer decides is more important.
- **Q: Are you following the very big changes in LED output and dropping price points. For example triple die single package LEDs from Sharp?**
  - We continue to follow the LED market. The 2008 LED report was up-to-date as of its publication date. More recent developments are covered in our monthly subscription newsletters and the free Display Daily.
  - I believe the Sharp LEDs you are talking about are targeted primarily at lighting applications (including keypad backlights), secondarily at LCD backlight applications and not at all at projection applications. We cover breaking news in the LED industry mostly in terms of LEDs for display applications.
- **Q: What are the wavelengths for the laser projectors?**
  - The nominal red, green and blue wavelengths are 630nm, 532nm and 462nm respectively. See the Insight Media 2007 Laser report or [Projection Displays](#) for a detailed discussion on the acceptable upper and lower wavelengths.
- **Q: Are LEDs much more shock/drop resilient than light bulbs?**
  - In general yes, but, of course, it depends on the detailed mechanical design.

- **Q: Are there upcoming improvements in lamp technology to bring costs down, and/or increase lamp life (to better compete with LED)?**
  - These developments are available, some now and some soon. As I discussed in the webinar, even today's lamps are cost competitive when you want more than about 100 lumens. LED-based projectors must be sold on the basis of LEDs advantages, since they cannot currently compete on price/performance, if performance is measured in lumens.
  - Lamps up to 4000 hours or more are available now.
- **Q: Comment on diffractive projectors (Light Blue Optics): diffractive SLM and laser combination**
  - Light Blue Optics has a problem independent of lasers and LCoS: it must convert the image into a hologram in real-time. This is a serious computing problem and I doubt it will ever fit in the size and power limitations of a picoprojector, although it might fit in an ultraportable. Diffractive SLM such as the Samsung SOM I am taking a wait and see attitude. Since they require lasers and lasers at the right price are not available this year, I see no hurry to rush to judgment.
- **Q: Are there any legal issues with high power laser projectors?**
  - Laser safety is a critical issue when you get beyond about 10 lumens. Every laser projector **must** be evaluated by a laser safety expert before it can be released as a product. I don't know of any other legal problems, however.
- **Q: Can you actually get 50 lm pico projectors that fit in your pocket today? Normally they range in ~10lm**
  - Not today, but remember it is only March. Read our Mobile Display Report for new, higher output picoprojectors. Besides, the 50 lumen threshold for pico/ultraportable was set somewhat arbitrarily to include the Dell projector. There is a gap in lumen output between the 10 – 15 lumen picoprojectors and the 50+ lumen ultraportables. I can't see anyone introducing a 40 lumen projector in a UP form factor, if they can't get it in a pico form factor they probably won't release it at all.

- **Q: Will laser based pico projectors be available much faster than laser based ultra-portables**
  - Probably since there are low-power lasers suited for 10 lumen projectors available now at reasonable prices.
- **Q: Do you foresee any safety issues related to laser projectors?**
  - Yes. A projector must qualify as class 1 or 2 or perhaps 3R to sell into a mass market. Current belief is any projector with 10 lumens or less would classify as class 1. The Wikipedia article on laser safety is a good place to start but if you are serious about building a laser projector, even one with less than 10 lumens, you should involve a laser safety expert from the very beginning of the design cycle.
- **Q: Are esoteric lamp technologies, like Luxim's LiFi likely to have any impact on this market?**
  - Insight Media does not foresee any light sources except LEDs, lasers, UHP-type lamps and possibly metal-halide lamps used in ultraportable projectors. High performance projectors can also use Xenon lamps. Luxim no longer targets projection with its LiFi lamp technology. Panasonic introduced RPTV with the LiFi lamp at CES 2007 and they still show up on the internet but they are no longer on the Panasonic website and I believe they have been discontinued.
- **Q: Was the lamp replacement cost considered when comparing the cost LED projectors to the Lamp based projectors?**
  - No, the BOM prices and other price estimates are for cost at time of purchase, not ongoing costs.

- **Q: Are there any reported issues with the LED-based ultraportables on the market that need to be addressed in future products?**
  - Real estate is location, location and location
  - Projectors are price, price and price.
- **Q: What is the expected lumen reduction over time for LED's?**
  - While I can't speak for any specific projector, lumen maintenance of 70% at 10k hours is achievable in most LEDs. For example, Lumileds cites 50% failure or 70% average luminance, whichever comes first, as the end of life for Luxeon LEDs. See the Insight Media LED report for more details on life of LEDs, or talk to the manufacturer.
- **Q: Discuss the relative lifetimes of LED & laser sources compared with lamps.**
  - See previous question for LEDs. Lamps fail in a variety of ways, one of which is a timer in the lamp or ballast to turn it off. See [Projection Displays](#) for a discussion of lamp life.
- **Q: Is the stated 2000 lumen limit just for ultraportables or for all LED-based projectors?**
  - The limit was specifically for ultraportables but realistically I don't expect any LED-based projectors to exceed this, except for very high priced specialty projectors such as ones optimized for visualization and simulation.

- **Q: Looking at the spectral power distribution of illuminants they do not correlate at all with color matching functions. How could you affirm that some of these sources have good colorimetry?**
  - When you measure color using LED or laser sources (assuming you do it correctly) you get the colors theory and calculation says you should. Qualitative examination of LED and laser projectors shows these colors are real and appear saturated.
- **Q: What does the complex drives for LEDs do to improve performance with DLPs?**
  - Improve contrast
  - Improve colorimetry
  - Improve gray scale
  - Increase lumen output for a given power input
  - The 2008 LED report contains a section on LED drivers, including the Osram RACPUR used with Luminus LEDs in the Delta projector. As improved drives come out, they will be written up in our monthly newsletters.