

OLED Lighting

– Poised to Take Off

Mike Lu PhD LC, Director Innovation & Product Development

OLED Business Group

Acuity Brands Lighting, Inc.

Luminaire Brands
Controls & Components



- FY 2014 sales: \$2.4 Billion
 - 1.7 million+ SKUs
 - 7,000 Associates
 - 16 Manufacturing Facilities
 - 14 Channels Served

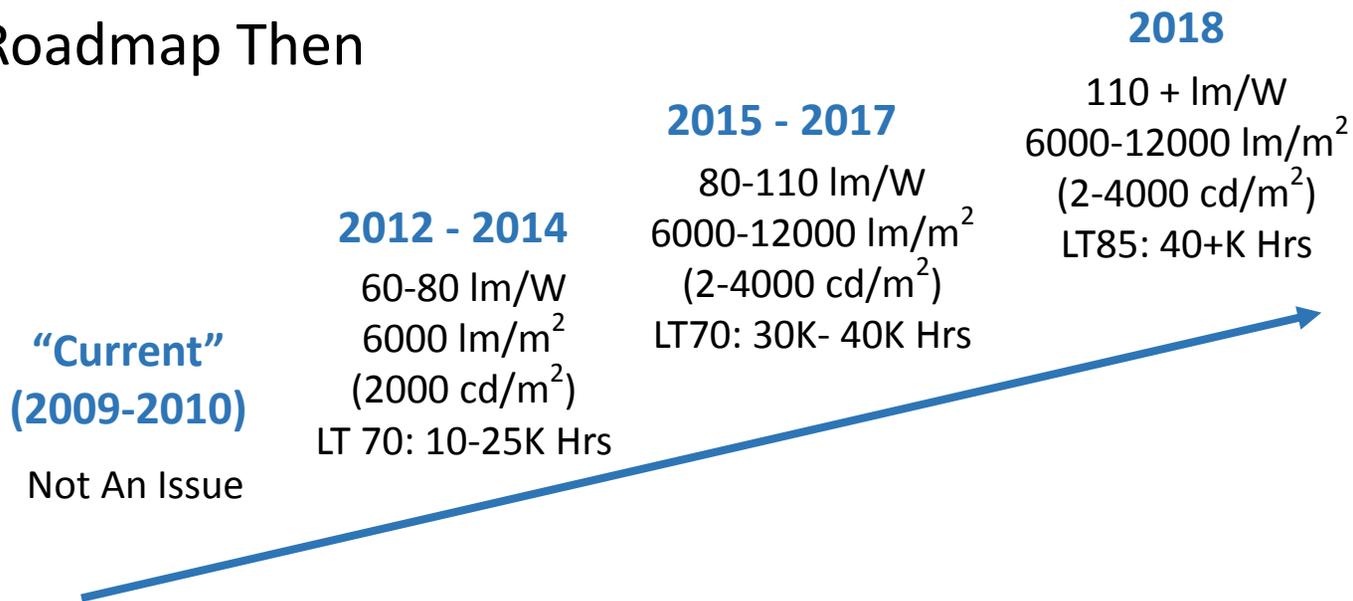
- #1 Market Share in North America

- Most Extensive Solutions Portfolio

- Evolution of OLED lighting requirements
 - How we got here
 - Next challenge

- Commercialization Efforts
 - OLED lighting needs to be experienced
 - OLED products in the retail market

Roadmap Then



- ❑ Focused on *demonstrating* a novel lighting technology
- ❑ Used 1st gen Osram Orbeos and LGC R&D panels
- ❑ Efficacy < 20 lm/W

Glimpse™



LightFacet



LightFair 2010

On the lighting design aspect of OLED lighting

Peter Y Ngai
Acuity Brands Lighting
2246 5th Street, Berkeley, CA, 94710

Proc. SPIE 7617, 761714 (2010).

Info. Disp. 26, pp. 10-13 (2010).

frontline technology

OLED Requirements for Solid-State Lighting

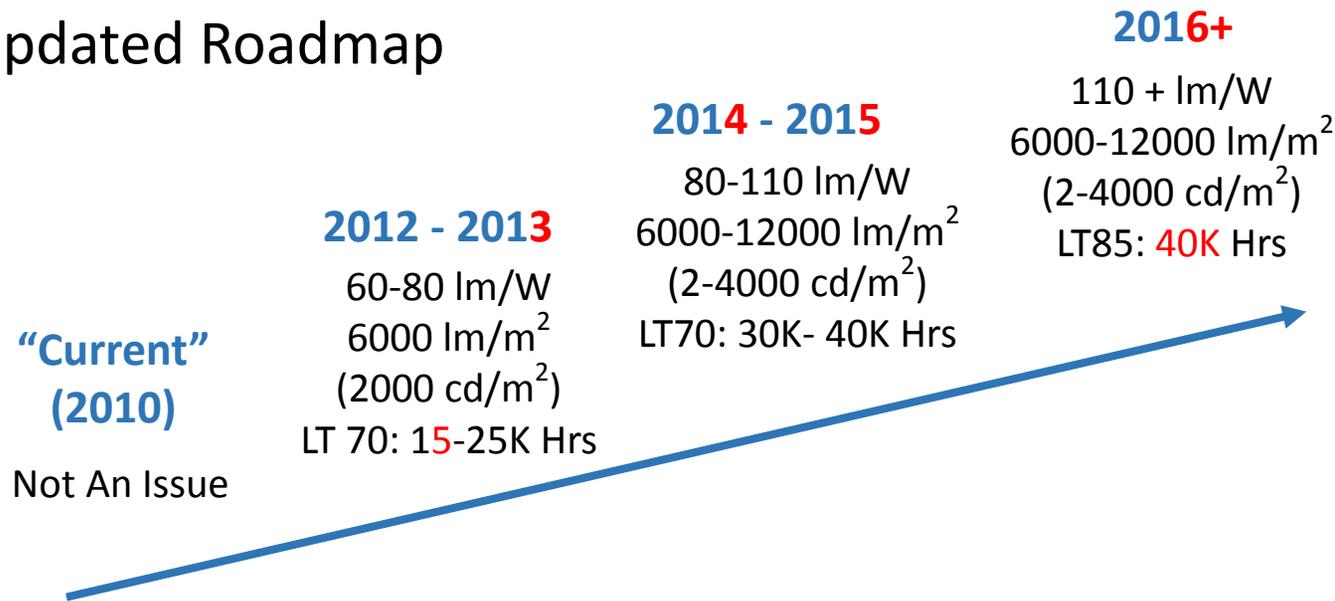
Rapidly improving efficacy and lifetime make OLEDs practical for general illumination. Panel requirements for a number of product categories from a luminaire manufacturer's perspective will be discussed. In particular, the necessary efficacy is derived from both required illumination and thermal constraints. Based on the progress reported with regard to hybrid tandem OLEDs at this year's SID Symposium,¹ OLEDs should be able to meet the product roadmap outlined in this article.

by Min-Hao Michael Lu and Peter Ngai

- Argued that ~60 lm/W is the minimum efficacy to commercialize OLED luminaires
 - Based on both Lighting Power Density (LPD) and panel temperature rise

EVOLUTION OF OLED LIGHTING REQUIREMENTS 2010 – 2011: EFFICACY FOCUS

Updated Roadmap



- ❑ Roadmap was compressed time-wise
- ❑ Edge-lit LED was perceived as a threat
- ❑ Accepted CRI Ra>80, R9>0
- ❑ Message to panel manufacturers: *Efficacy* (targeting 60 lm/W) was the primary focus



LightFair 2011

- ❑ 1H2012, LGC started to mass produce ~60 lm/W panels
- ❑ Acuity started offering Revel, Kindred, Trilia and Canvis on a *custom* basis under the Winona brand
- ❑ Focused on feature spaces; larger office spaces also possible by utilizing high “application efficiency” designs

Trilia™



Canvis™



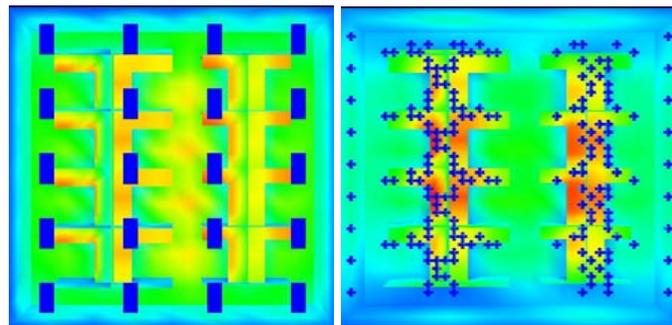
LightFair 2012

Application Efficiency of Indoor OLED Lighting

Jeannine Fisher, Peter Ngai, and Min-Hao Michael Lu

OLED Lighting Design Center, Acuity Brands Lighting Inc, Berkeley, CA, USA

IDMC, S23-01, Taipei, Taiwan (2011)



- Market feedback: better color quality needed when presented as a high-end, feature space solution
- Message to panel manufactures: need higher CRI, lower *Duv*, etc.

THEN

CRI Ra > 80, R9 > 0
Duv = 0~0.004

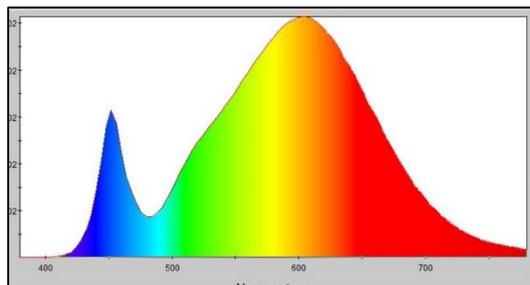
NOW

CRI Ra: 88-90, R9: 20-30
Duv = -0.004~0

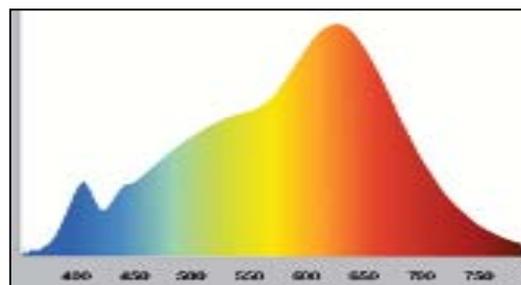
TARGET

CRI Ra > 90, R9 > 50
Duv = -0.002~0

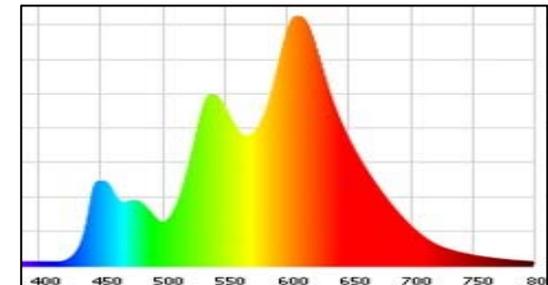
LED and OLED Spectra Comparison



Typical 3000K pc-LED lamp:
 Lamp Efficacy: 60-70 lm/W
 CRI: Ra 75-90, R9: >0

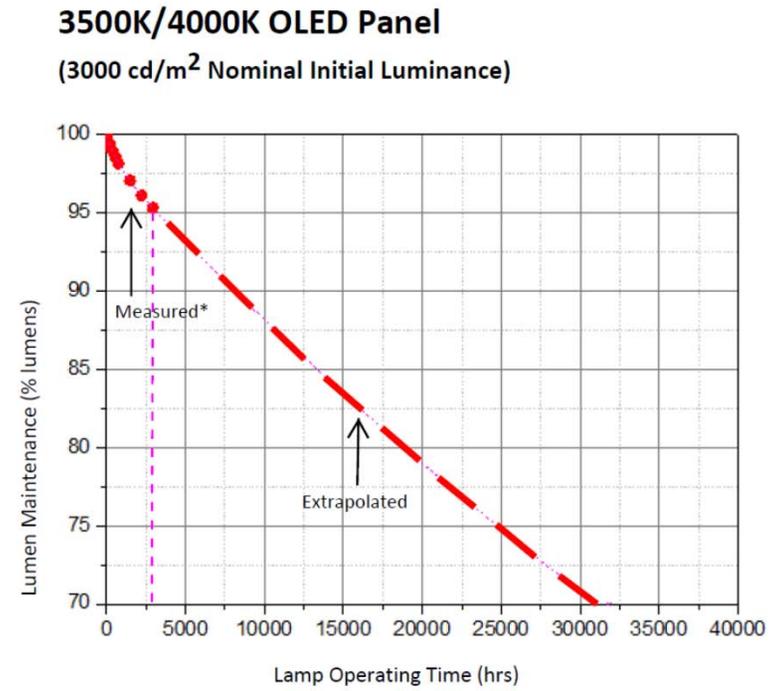
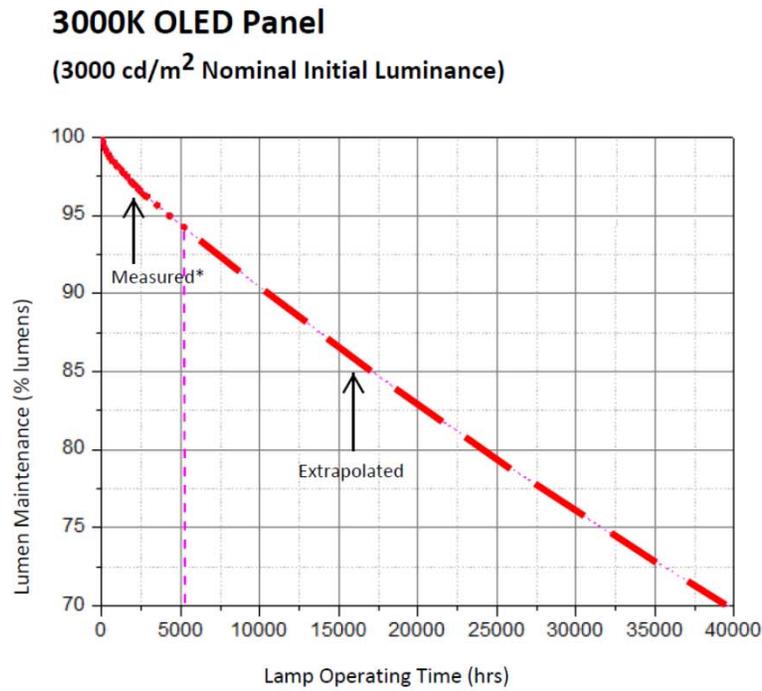


Typical High-CRI 3000K “multi-phosphor” LED lamp:
 Lamp Efficacy: 47-59 lm/W
 CRI: Ra ≥95, R9: ≥90



High-CRI 3000K OLED panel **TODAY**:
 Panel Efficacy: 59 lm/W
 CRI: Ra 89, R9: 29

EVOLUTION OF OLED LIGHTING REQUIREMENTS 2013-2014: LIFE TIME, RELIABILITY

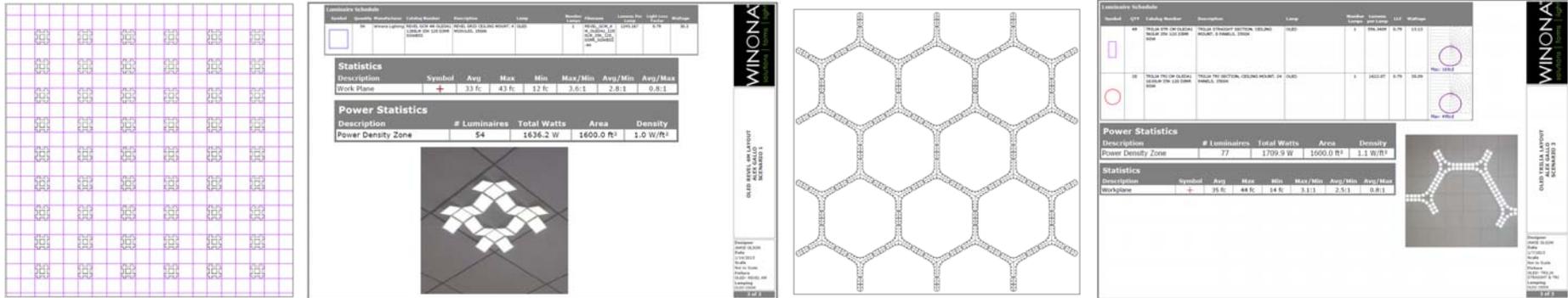


* Measured Data at 25°C Ambient Operating Temperature

LGC data

- ❑ Significant lifetime improvement, $L_{70} = 30-40$ Khrs
- ❑ Significant improvement in panel reliability

Lighting Design Study with OLED Luminaires for General Illumination

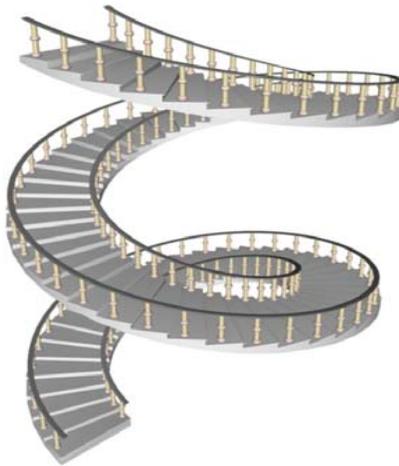


Foot Candles		Watts Per Square Foot		
IES	AB OLED	California Title24*		AB OLED
	<u>Target</u>	<u>2013 Target</u>	<u>2016 Target</u>	<u>Achieved</u>
Revel @ 55 lm/W panel	Achieved** 33	0.75	0.75	1
Trilia @ 55 lm/W panel	35	0.75	0.75	1.1
Revel @ 80 lm/W panel	33	0.75	0.75	0.7
Trilia @ 80 lm/W panel	35	0.75	0.75	0.7

Need panel efficacy of 80 lm/W to exceed LPD for CA title 24!

- ❑ After almost five years, the development focus is once again on panel efficacy – after significant progress on multiple other fronts.
- ❑ Factor in the dependency of efficacy on spectrum (20-30% hit on efficacy for high CRI), the industry is keeping pace with our 2010 roadmap projections.

THINK



NOT



More than anything...

More than LPW, \$/KLM, W/ft² ...

OLED lighting needs to be experienced ... lived ...

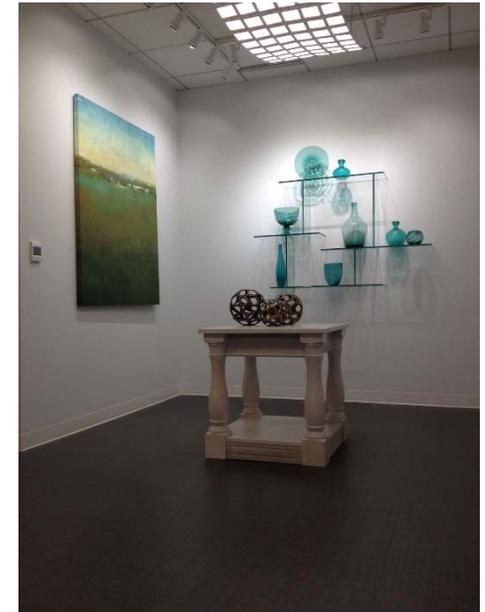
Kindred



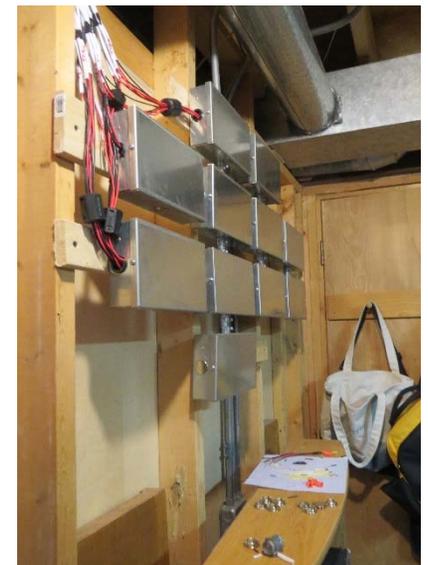
Trilia and Revel



Canvis



Installation



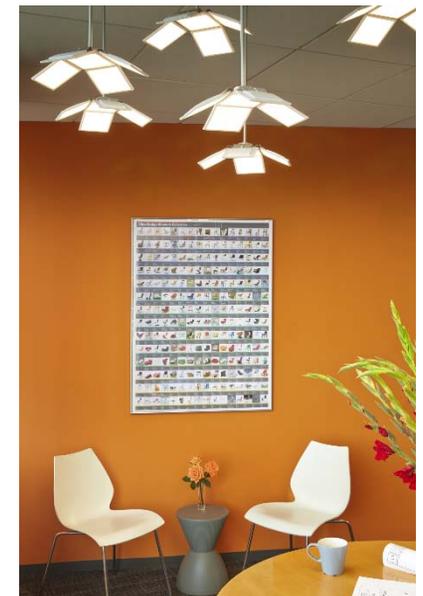
Courtesy Leslie North, Aurora Lighting Design

Trilia



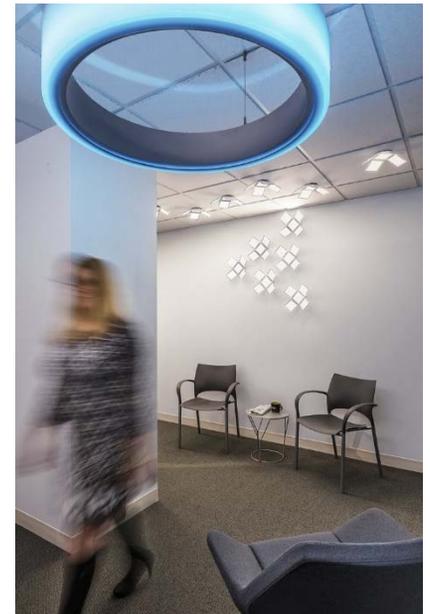
© Mark Ballogg 2014

Revel



© John Sutton 2014

Revel



© Mark Ballogg 2014

Case Study

connection to nature. It hints back to something more organic, more inspiring," said North. "There is something about this particular product that lends itself to a creative connection. When visitors are in our space, they are often so intrigued that they ask to physically touch it."

North also indicated that the use of OLED lighting in residential spaces is bound to evolve and grow. "It's definitely a technology that can be used in cross-over products. As for the Trilia OLED luminaire specifically, if we converted our office space into a recreational space like it would naturally be in a residential setting, we could put a pool table under it and make it a heck of a rec room!"

#

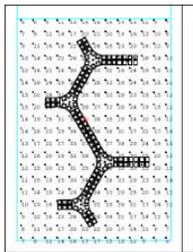
Details:

Project: Aurora Lighting Design, Chicago, Ill.

Lighting Designer: Leslie North and Ashley Mikels, Aurora Lighting Design

Lighting Manufacturers: Acuity Brands / Winona Lighting

#

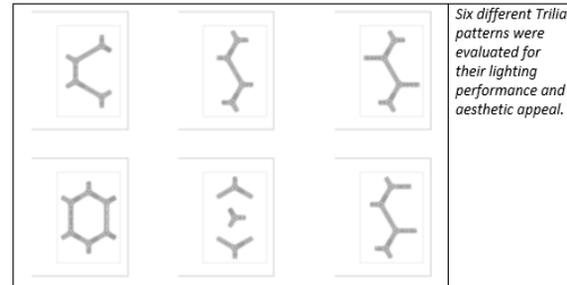


Lighting Performance Statistics:

Maintained illumination at the table
30+ fc

Lighting power density
0.63 W/ft²

Lighting control strategies via wallbox
system
Manual dimming



Six different Trilia patterns were evaluated for their lighting performance and aesthetic appeal.



Close-up view of the final Trilia pattern illustrating how it looks like the ceiling was designed around the lighting – a lighting designer's dream-come-true!

Case Study

Revels Overlook the San Francisco Bay at 16500 Offices

16500, an exclusive San Francisco Bay Area factory authorized representative for some of the finest architectural, commercial, institutional, industrial and residential lighting and lighting controls manufacturers, is located at 2100 Powell Street in Emeryville, CA.

2100 Powell is a 16-story, 344,433-square-foot suburban office building. Designed by Korth Sunseri Hagey Architects, it became a striking addition to the Emeryville skyline in 2001 and was acquired by Hines REIT in 2006. In 2013, 16500 relocated their offices to the 8th floor of this building not only for the breathtaking, unobstructed view of the area's most prominent landmarks - the San Francisco skyline, San Francisco Bay, Bay Bridge, Golden Gate Bridge, Mount Tamalpais, and the Berkeley and Oakland hills - but also to create a hallmark of sustainable design. With the close proximity to Interstate 80, the site is the most centrally located office building in the East Bay. Serviced by Emery Go Round, a complimentary shuttle linking 2100 Powell to main public transit arteries, including BART, Amtrak and the Transbay bus service, 16500 can attract the best talent in the Bay Area, while providing easy access to public transit for its employees. The building itself is Energy Star 2008-2014 and achieved LEED Gold status in 2010.

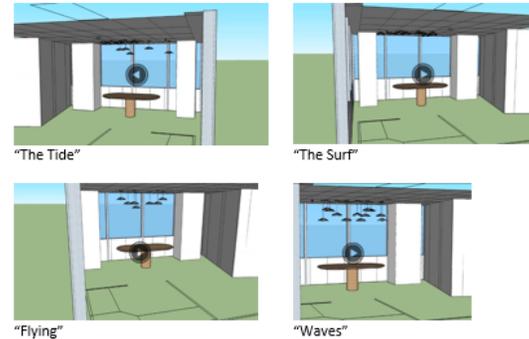


A primary goal of 16500 when they moved their office was to create a space that showcased the very best in lighting design and application while achieving extraordinary levels of energy savings through utilizing progressive and efficient luminaires in conjunction with innovative and intuitive lighting controls strategies. Nearly all luminaires are controlled via a digital lighting system utilizing timeclock and manual shut-off, occupancy sensing, daylight dimming, lumen maintenance dimming, and manual control strategies optimized for individual spaces. A suite of traditional and sophisticated graphical control stations are used throughout the project tailored to the complexity of the lighting design and user interface requirements of each space. The overall design, based entirely on the use of Solid State Lighting, achieves an incredibly low overall lighting power density of 0.60 W/ft², 25% below the 2013 CA Title 24 Building Energy Efficiency Standards requirement.

When it came to lighting a special collaborative area / conference space on the northwest corner of the floor, 16500 considered many lighting options. The lighting experts at the firm wanted a lighting design that builds on the energy efficiency story of the whole project while achieving many other functional and aesthetic goals. It wasn't just enough to provide glare-free comfortable and adequate illumination. The lighting had to convey the true interactive nature of the space and be as breathtaking as the view beyond.

Finding the Solution

The moment of inspiration came as Ayse Aktari, lead Specification Sales Specialist at 16500, gazed out her window watching a flock of birds flying over the shimmering bay. The Revel™ OLED luminaire from Acuity Brands allows so much versatility and freedom of design, it could deliver everything the firm was looking for. Ayse, an artist by training, began sketching her ideas. Four different designs, all using some variation of the Revel OLED lighting system, were evaluated for lighting performance and emotional appeal.



While perhaps appearing only subtly different in these cartoon-like renditions, the vision was clear in the eyes of the artist. Aktari selected the "Flying" design, reminiscent of the birds floating in the sky over the Bay. Twelve Revel pendants are located in a random pattern in random orientations at varying overall suspension heights of 12", 18" and 24" in a ceiling height of 9 feet. The OLED light source is 3500K, consistent with the CCT of the other luminaires used throughout the 16500 offices.



Results

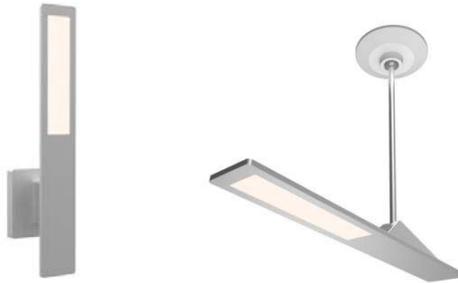
Not only do the Revel luminaires provide a look fitting to the space and view, but the design achieves even higher levels of efficiency than the overall project, which sets an already high benchmark. At less than 10W per luminaire, the lighting power density for this conference room space illuminated solely by the Revel is only 0.41 W/ft² while providing a maintained illumination level of over 30 footcandles on the table surface. The diffuse nature of the OLED lighting also ensures good vertical illumination, both inviting and flattering to those interacting below.

According to Paul McDowell, Principal and Founder of 16500, "Our firm recognizes the importance of walking the talk, so to speak, and making our own offices an embodiment what we sell - the best architectural lighting solutions on the market. We are particularly excited when we have the opportunity to showcase a new



Chalina™

- ❑ Pendant-mount and wall-mount
- ❑ Uses (5) LGC 100x100 mm² panels
- ❑ 345 lm, CCT 3000K, 40,000 hrs expected life
- ❑ 0-10V dimmable, 46.9 lm/W



Aedan™

- ❑ Pendant-mount and wall-mount
- ❑ Uses (2) LGC 50x200 mm² panels
- ❑ 136 lm, CCT 3000K, 40,000 hrs expected life
- ❑ 0-10V dimmable, 31 lm/W

Brand: *Acuity Brands*

This Is a Watershed Moment for OLED Lighting.

- The Motley Fool

COMMERCIALIZATION EFFORTS

PHYSICAL STORE PRESENCE



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\$299.00 / each Was \$399.00 Save 25%	\$299.00 / each Was \$399.00 Save 25%	\$199.00 / each Was \$249.00 Save 20%	\$199.00 / each Was \$249.00 Save 20%
Acuity Brands Chalina 5-Panel Brushed Nickel OLED Pendant	Acuity Brands Chalina 5-Panel Brushed Nickel OLED Flush Mount Light	Acuity Brands Aedan 2-Panel Brushed Nickel OLED Wall Mount Sconce	Acuity Brands Aedan 2-Panel Brushed Nickel OLED Pendant
Model # CHALINA-PM-OLEDA1-5P-345LM-30K-120191001P	Model # CHALINA-HCWM-OLEDA1-5P-345LM-30K-120191001P (1)	Model # AEDAN-WM-OLEDR1-2P-140LM-30K-120191001P (1)	Model # AEDAN-PM-OLEDR1-2P-140LM-30K-120191001P
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