

## Choosing the Proper LED lamp for Down Lighting Applications

Israel J. Morejon – CEO, LEDnovation Inc.

Jim Zhai – Chief Optical Engineer, LEDnovation, Inc.

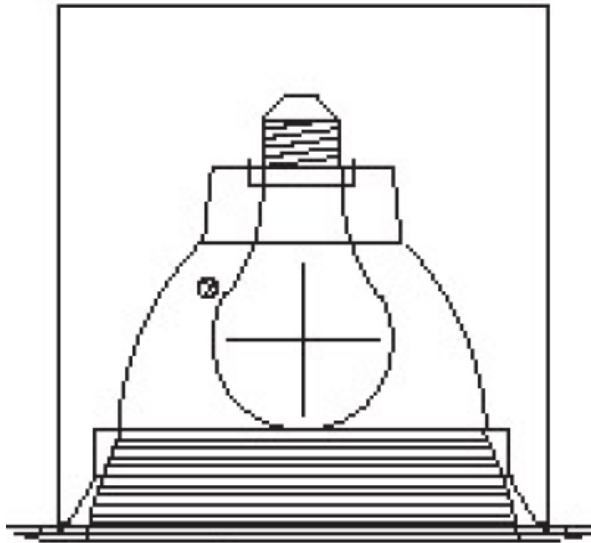
Evan O’Sullivan – Vice President of Engineering, LEDnovation, Inc.

### Abstract

In any mature industry when a completely new technology disrupts the status quo there is a period of education needed before the new technology can truly be used and accepted. This is true of the lighting industry and LED lighting. When properly used, LED lighting will not only realize substantial energy savings but can also enhance the user’s experience. Without a proper understanding of how and when to utilize LEDs lamps properly, many users will have less than optimal experiences. This paper will focus on LED lamps and how select the proper lamp for down lighting applications.

### Introduction

At its most simplistic level a lighting system is comprised of a light source (lamp) and a fixture that houses this light source (*Figure 1*). The fixture provides electrical power, reflects a small percentage of the wasted light, and steers the light to where it is really needed. Quite often the fixture alters the beam shape of the original light source.



*Figure 1 – Lamp position in a typical downlight*

The goals of this paper are to 1) illustrate the differences between directional and omnidirectional lamps, 2) explain the actual parameters that are important when selecting a lamp for a particular application, and 3) provide a real world example of when using a directional lamp yields far greater efficiencies compared to an omnidirectional lamp.

The examples and discussions contained within this paper examine light levels (lumens and foot-candles) and efficiency. There are many other important factors in selecting a lamp such as Color Rendering Index (CRI), Correlated Color Temperature (CCT), Color Quality Scale (CQS), etc. For the purposes of this discussion it is assumed that the target lamps already meet these “quality of light” requirements.

Choosing the proper lamp – Equivalency claims

The goal of a lighting system is to provide the proper amount of light, as measured in foot-candles, on a work surface, walkway, or whatever the intended application requires. Lamps were traditionally selected by specifying Watts. “Our current lamp is a 60 Watt” was the norm for describing a lamp. A 100 Watt lamp equated to a particular lumen output which was known to be greater than a 75 Watt lamp which was greater than a 60 Watt lamp, etc. LED lamps are different; the amount of lumens and watts or their efficiency varies widely among manufacturers. LED lamps are also much more efficient than incumbent technologies, and thus the lamp is no longer a “60 Watt” lamp but more correctly perhaps a 6-12 Watt LED lamp. How do we equate the two?

One way is with lumens, or the raw amount of light output from the lamp. Unfortunately lumens alone do not tell the entire story. How useful would a 900 lumen lamp be if 100% of the light was directed up into the ceiling! We are steered back to making sure that the lamp chosen provides the proper foot-candles at the application surface. So how do we choose the best lamp for a particular application?

Choosing the proper lamp - Light Patterns – Direction versus Omnidirectional

Incandescent lamps, and also compact fluorescent lamps (CFL), emit light in an omnidirectional pattern. *Figure 2* below illustrates an omnidirectional light pattern. The light is emitted in the forward, side, and reverse directions. *Figure 3* below illustrates the directional pattern or cosine distribution of a LEDnovation A19 directional lamp.

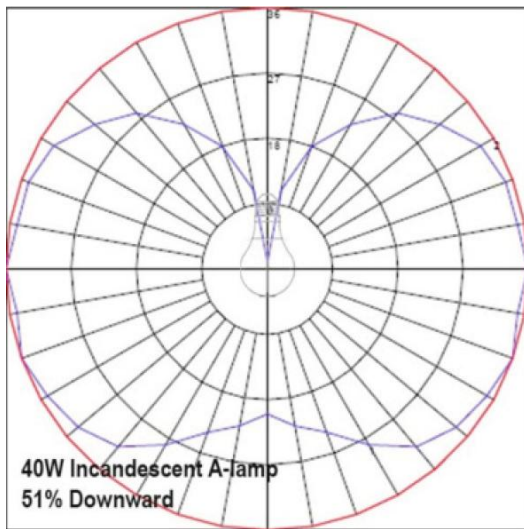


Figure 2 – Omnidirectional pattern

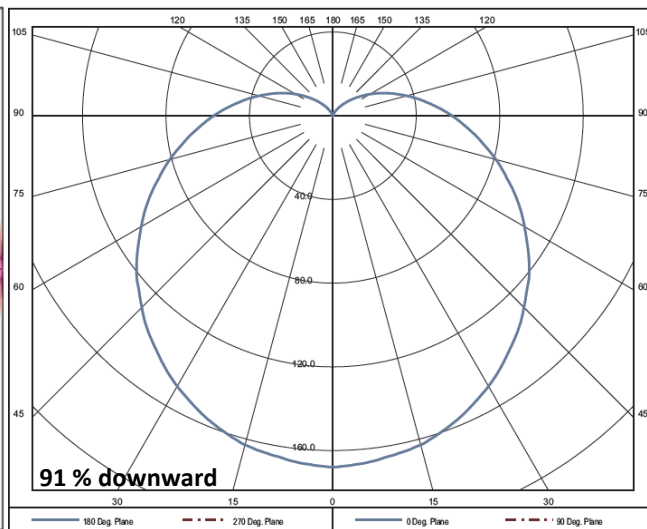


Figure 3 – LEDnovation directional A19 lamp

In tabular form a clear percentage distribution can be compared between the LEDnovation lamp and the Incandescent and CFL bulbs.

Lamp types	Light downward – bare lamp	Light upward – bare lamp
LEDnovation Directional A-lamp	91%	9%
A19 Incandescent Lamp	51%	49%
Compact Fluorescent (CFL)	51%	49%

Figure 2 illustrates that a 60 Watt incandescent directs approximately 51% of the light in the downward direction, with 49% in the upward direction. Figure 3 illustrates that 91% of the light from the LEDnovation lamp is in the downward direction with only 9% upward. For a quick calculation we assume that all of the downward light escapes the fixture and that approximately 20% of the wasted upward light is recycled in the downward direction. A further point, in the case of a self ballasted lamp such as a CFL or LEDnovation LED lamp the ballast is contained within the lamp and thus Lamp Power is all that is required for the calculation.

In the example above if we used a 60 Watt - 800 lumen incandescent lamp we would yield approximately 486 lumens out of the fixture whereas starting with a LEDnovation 6.15 Watt lamp would yield 571 lumens. The LEDnovation lamp yields more lumens on target than the incandescent for a similar downlight application. In this application 85 more lumens, or approximately 17% more light, is delivered by the LEDnovation lamp than the incandescent.

Fixture efficacy is described by the following equation:

$$\text{Fixture Efficacy (FE)} = (\text{Lumens out of Fixture}) / (\text{Lamp Power} + \text{Ballast power})$$

Lamp type	Lamp power	Lamp total Lumens	Lumens in downward direction	Recycled lumens 20%	Total Lumens out of fixture	Fixture efficacy
60W Incandescent	60 Watts	800 lumens	408 lumens (51%)	78.4 lumens	486 lumens	486/60 = 8.1 lumens per watt
6W lamp LEDnovation	6.15 watts	615 lumens	560 lumens (91%)	11 lumens	571 lumens	571/6.15 = 93 lumens per watt

Figure 4 – Real world example of directional versus omnidirectional lamps

The point illustrated in Figure 4 cannot be understated. Choosing a lamp purely based on lumen output may not yield the best results *in the intended application*. The fixture efficiency of the example above is only 8.1 lumens per watt using a 60 Watt incandescent but 93 lumens per watt using a LEDnovation 615 lumen/6.15 Watt lamp.



The quickest way to determine foot-candles in a particular application is to use the IES file (photometric plot) for the lamp and simulate it in a particular fixture using readily available software. The illustration below shows the expected foot-candles using a standard 60 Watt incandescent in a 5 by 10 grid of lamps. The spacing and other simulation parameters are listed on the right side of the simulation. The 60 Watt incandescent yields an average of 30 foot-candles of light on target at a power density of 5.00 Watts/ft<sup>2</sup>.

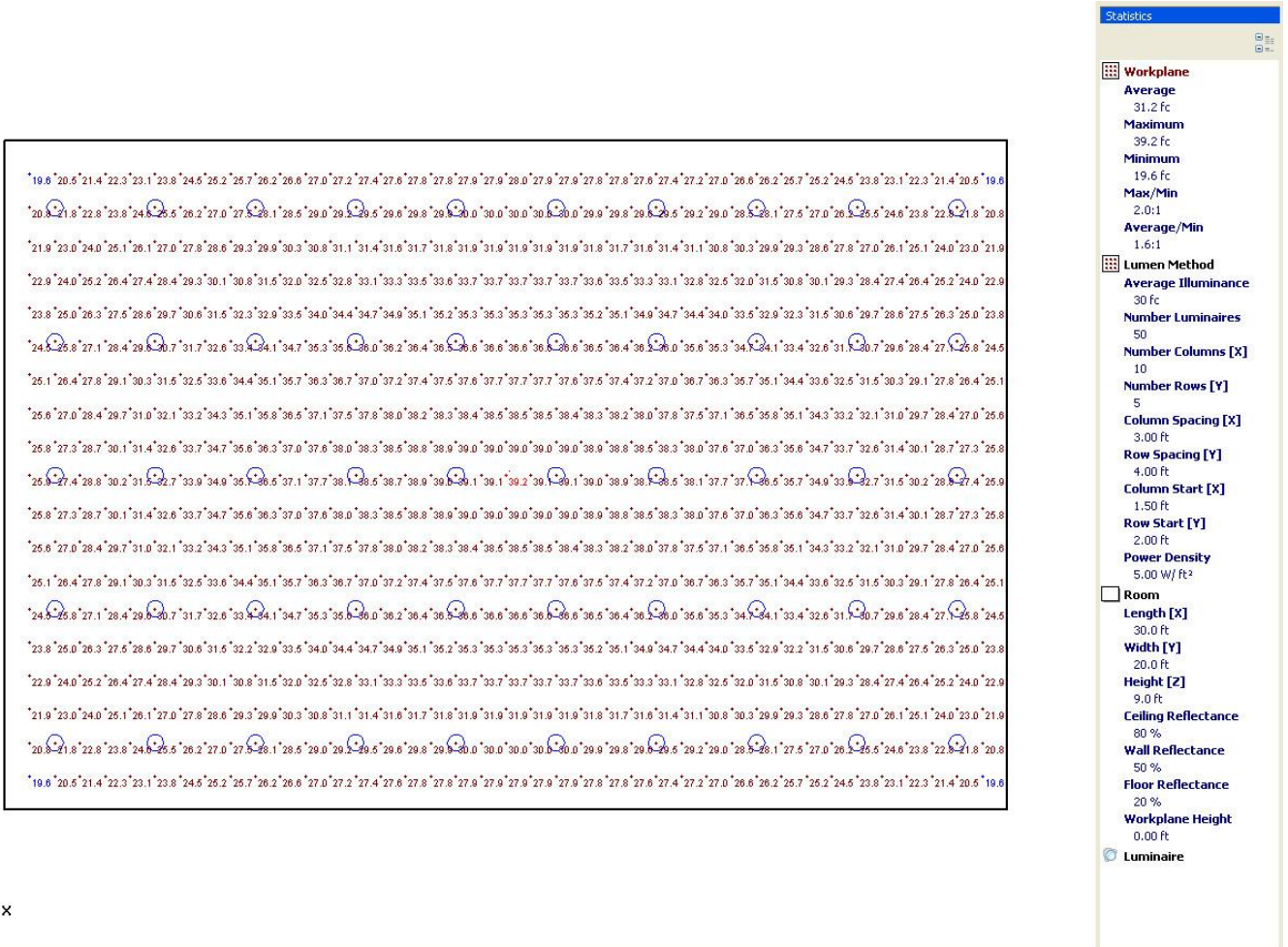
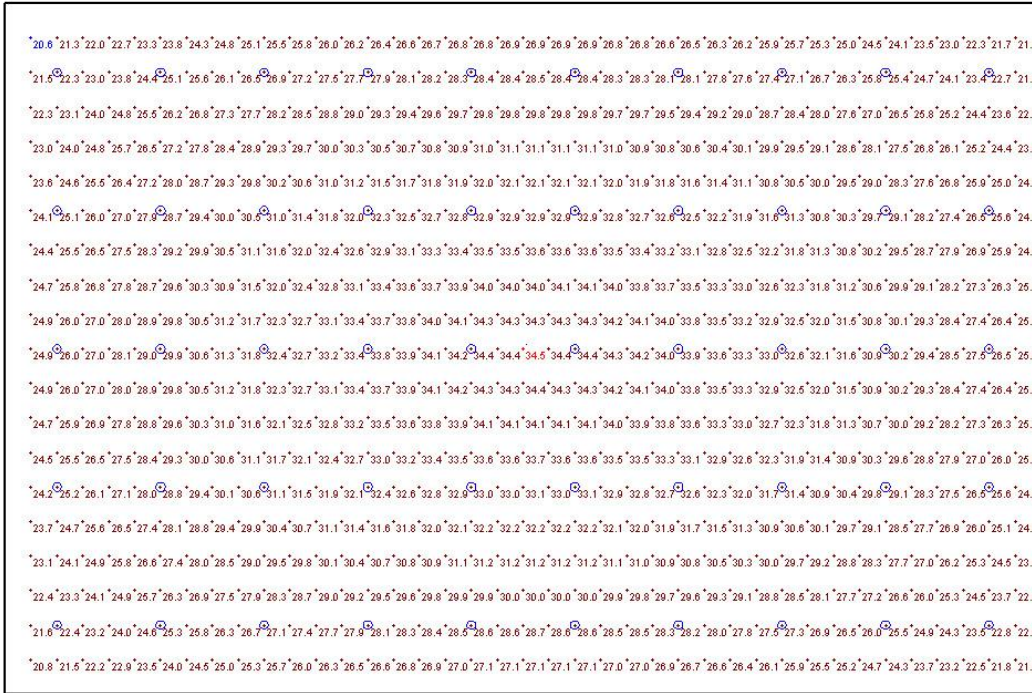


Figure 6 – In-Situ photometric simulation of a 60 Watt incandescent lamp

As is illustrated from the simulation below, the LEDnovation lamp, which is tailored for down lighting applications yields an average of 31 foot-candles on target while keeping the power density at an extremely low 0.5 W/ft<sup>2</sup>. This is a tenfold reduction in power density compared to the incandescent.



Statistics

- Workplane**
  - Average: 29.1 fc
  - Maximum: 34.5 fc
  - Minimum: 20.6 fc
  - Max/Min: 1.71
  - Average/Min: 1.41
- Lumen Method**
  - Average Illuminance: 31 fc
  - Number Luminaires: 50
  - Number Columns [X]: 10
  - Number Rows [Y]: 5
  - Column Spacing [X]: 3.00 ft
  - Row Spacing [Y]: 4.00 ft
  - Column Start [X]: 1.50 ft
  - Row Start [Y]: 2.00 ft
  - Power Density: 0.50 W/ft<sup>2</sup>
- Room**
  - Length [X]: 30.0 ft
  - Width [Y]: 20.0 ft
  - Height [Z]: 9.0 ft
  - Ceiling Reflectance: 80%
  - Wall Reflectance: 50%
  - Floor Reflectance: 20%
  - Workplane Height: 0.00 ft
- Luminaire**

Figure 7 – In-Situ photometric simulation of a LEDnovation 6.15 Watt lamp

### The Two Approaches

In the quest to replace traditional incandescent light sources with more efficient LED light sources for down light applications there are two schools of thought. The first one tries to mimic the original light source distribution *exactly*. The second school of thought, and the one offering greater advantages, examines the actual use of this light source in the lighting system and takes advantage of the new technology to achieve even greater efficiencies while meeting or exceeding the lighting specifications of the original system. This is the LEDnovation approach to down lighting applications using directional A19 lamps.

### Conclusion

This paper has highlighted the need to consider the actual application when choosing an LED replacement lamp. Speaking in terms of “Watts” is no longer a valid way to compare lamps of different technologies. Even speaking in “Lumens” does not tell the entire story when the light output distribution of the two lamps are different. In order to choose the best lamp, the actual usable light delivered to the target must be determined. Once the lighting requirements are defined then it is possible to simulate the performance of different lamps in the system to determine which lamp meets the lighting requirements and also offers the most efficient solution. In conclusion, a lamp specifically tailored for down lighting applications like LEDnovation directional A19 lamps have the capability to offer the most efficient solution.

For more information on how to choose the proper LEDnovation lamp for your application please contact the LEDnovation Sales representative listed on our website [www.lednovation.com/contact](http://www.lednovation.com/contact) .

## Appendix

LEDnovation LM-79 report

Document title – “LM79-LEDH-A19-60-1-27D-I.pdf”

Link : <http://www.lednovation.com/products/pdf/LM79-LEDH-A19-60-1-27D-I.pdf>