LIGHTFAIR INTERNATIONAL

The future. Illuminated.

2005

Seminar 3 LEDs, Innovation Application & Evolution

April 12, 2.00 to 3.30

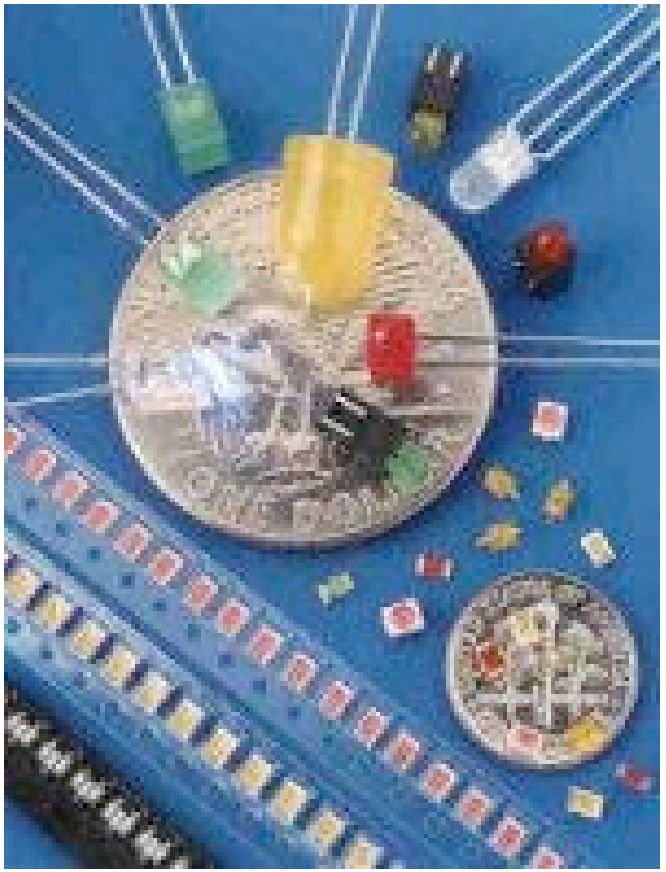
Kevan Shaw

kevan shaw lighting design

IES IALD AMC LD+A

Defence Against Dark Arts

- Overview, LEDs
  - Why use them
  - Consider specification
  - What to avoid
  - How to make it work



Case Study

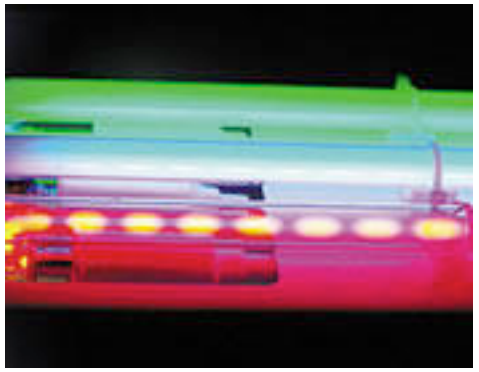
- Public Institute for Social Security
  - Government Building
  - 23 Floor Tower
  - Prominent Site
  - Landmark at Traffic Junction

The Brief

- Year Round : Express identity
- Celebration Lighting : Annual Events
- Flexible and Changeable
- Access Difficult : Low Maintenance
- Construction well underway

The Response

- Consideration of concept
  - Integrate with Architecture
  - Lit Surfaces not points of light
  - Colour effects for celebration
- Consider technologies
  - Mechanical colour change
  - Additive colour mixing
  - LED additive colour change



PIFSS Presentation

- Night Time Identity
  - Simple and Clear
  - Reflect Form and Detail

- Celebration Lighting
  - Dynamic
  - Considered Colour Use

Why LEDs

- Solid state, no moving bits
- Robust
- Highly flexible through programming
- Expected Long Life
- Efficient way to get color change

Design Development

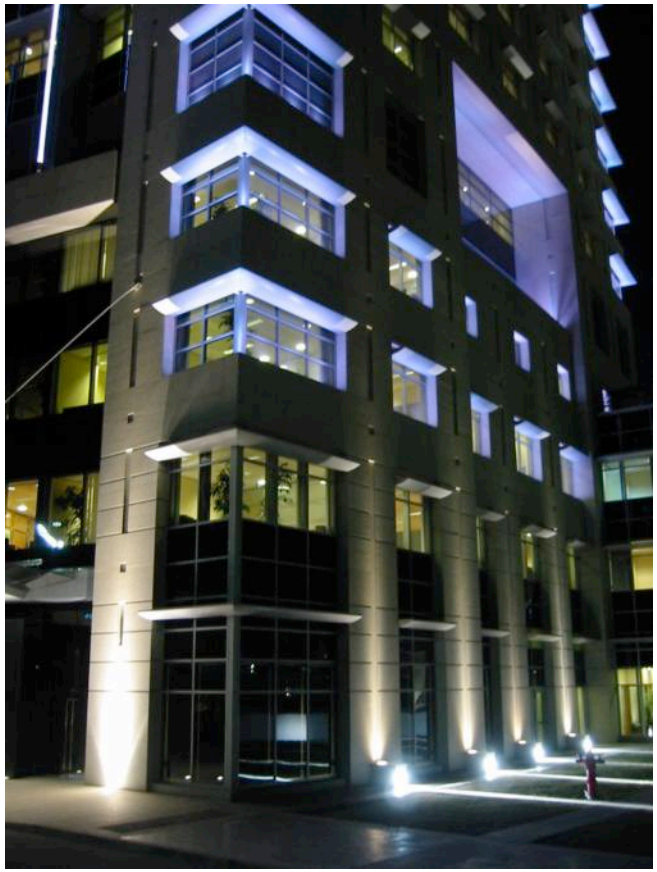
- Project already well advanced
- Detail integration urgent and limited by progress
- Consider technology issues
  - Heat Dissipation
  - Cable Network
- Consider suppliers
  - Track Record
  - Willing to engage with the project

Integration with Architecture

- Lighting architecture
- Hiding fixtures
- Minimize access

Balance with Other Lighting

- Control surface brightness
  - Use changes in materials
- Create contrast between elements
  - Offset colours



Control Strategy

- Single standard protocol
  - DMX 512
  - Established knowledge and equipment base

- Application of Theatrical Systems
  - Experience with flexible requirements
  - Tried and Trusted system and software
  - Experience of programming shows

Lighting Equipment

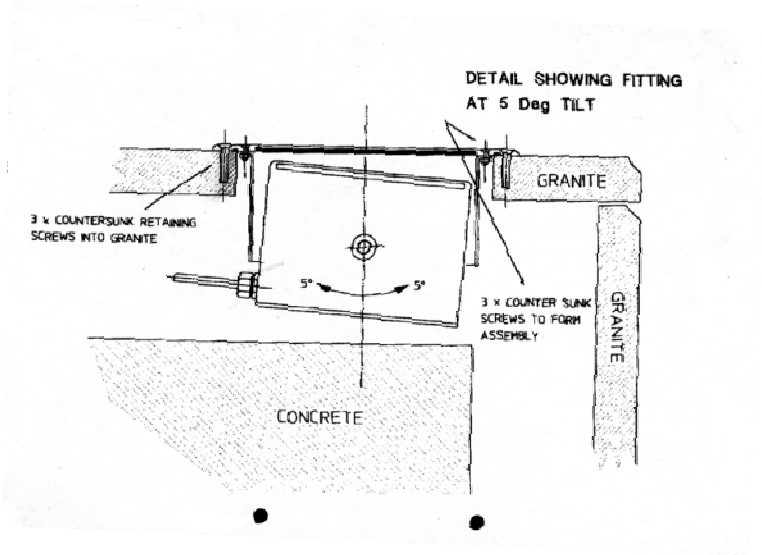
- Selection of fixtures
  - Consider requirements
  - Integration requirements
  - Environmental factors
  - Supply routes
- Some standard fittings
- Some custom fittings

Standard Fixtures

- Colour Blast
  - Wash roof details
- Light Pipe
  - Edge details
- Chromacore Boards
  - Same technology
  - Same LEDs

Custom Fixtures

- Recessed fixtures
  - No standard fitting available
  - Specified as modification
  - Consideration of detail
  - Use same Chromacore technology for colour consistency



- Supply issues
  - Manufacturers reluctant to alter fixtures
  - Qualification of potential suppliers
  - Review of products

Specification Issues

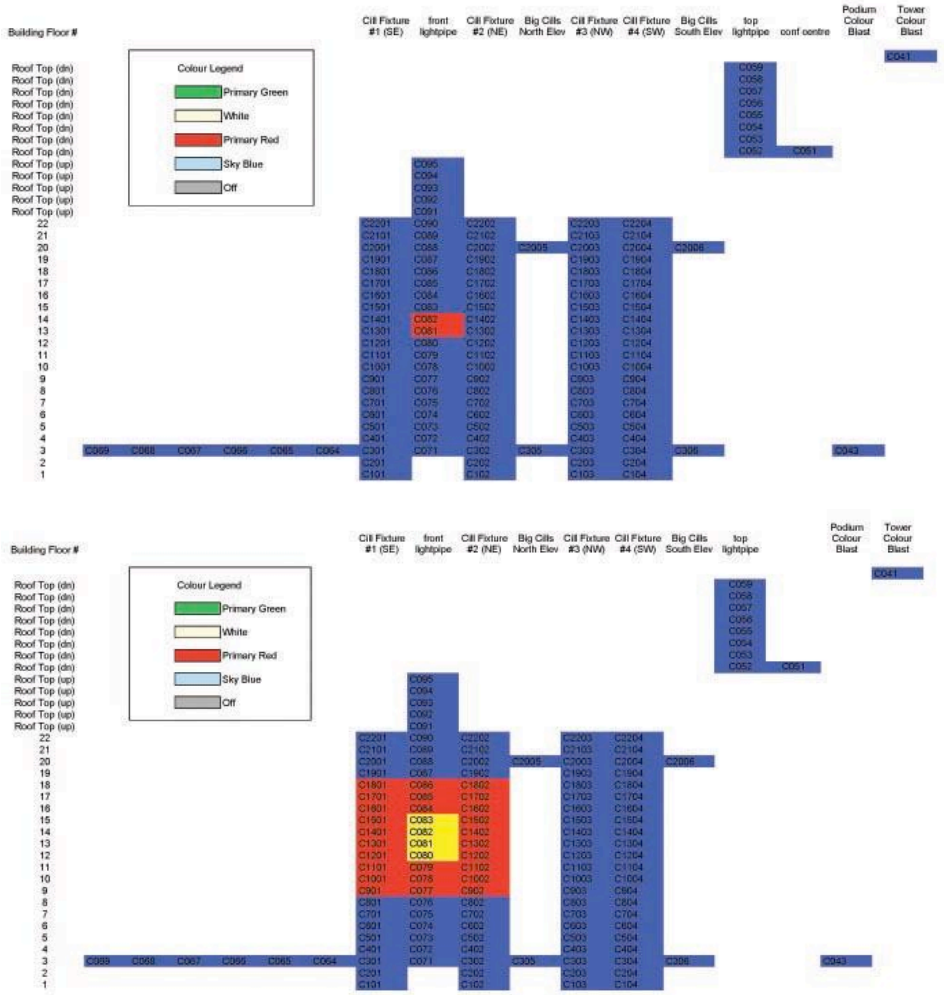
- Environmental:
  - High solar gain in day
  - Dust ingress
  - Surface dust adhesion
- Design:
  - Colour consistency
  - Same boards and LEDs
- Buildability
  - DMX addresses preset
  - Focus Preset

Construction Issues

- Spec busting
  - Refusal Pricing
  - Unequal pre tender effort
- Involvement
  - Maintain contact with manufacturers
  - Advise and review proposals

Preparation for Commissioning

- Develop story boards
  - Agree format with controls supplier
- Off Site Programming
  - Set up system
  - Enter as much as possible
  - Remain flexible



Site Programming

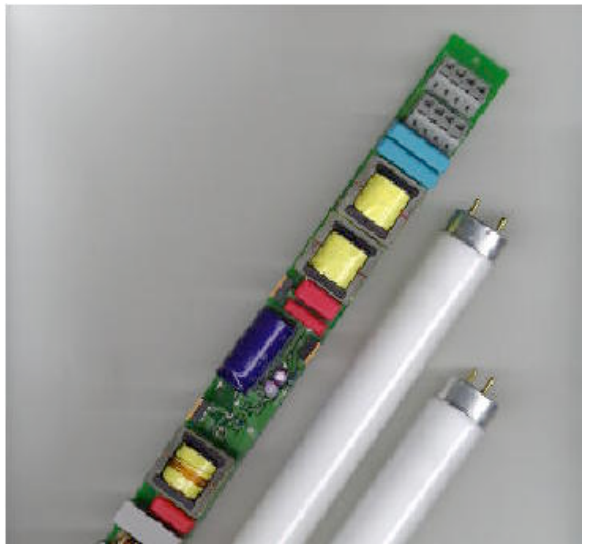
- Make sure it all works!
  - Ask contractor
  - Ask suppliers
- Don't believe them!
  - First job - check it all
  - Allow for fault finding
- Agree plan of action
  - With contractor and programmer
- Allow for recording results
  - For evidence
  - To aid memory

LEDs A Different Technology

- Lighting is Low Tech
  - Simple electronics
  - Unsophisticated thermal design

- LEDs High Tech
  - Integrated electronic system
  - Thermal design critical

- Lighting manufacturers
  - Specialist manufacturers unfamiliar with lighting market
  - Lighting manufacturers rush to market unfamiliar with technology



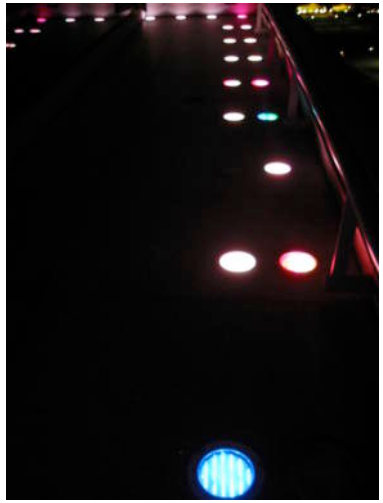
Changing Technologies

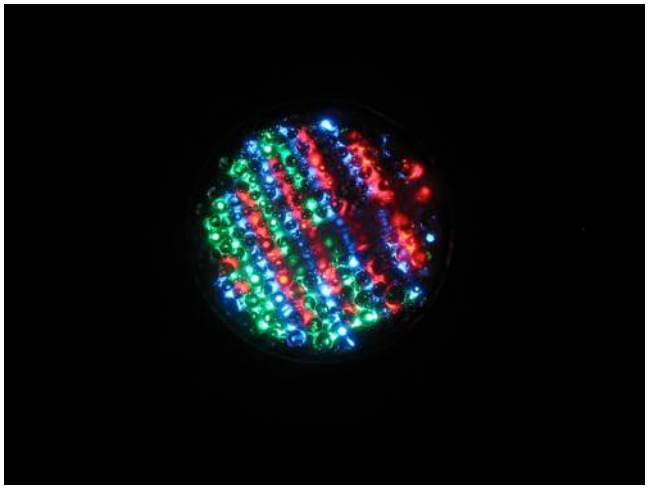
- LEDs develop quickly
  - Semiconductor technology
  - **Moore's Law : component count on IC doubles every two years**
  - **Haitz's Law : performance increases by factor of 20 cost reduces by factor of 10 every decade**

- Technology changes during project
  - **Shaw's Law : LED lighting products will be out of date by the time they are installed on a project**
  - New technology means new knowledge required
  - Unproven systems offered
  - Proven systems quickly discontinued

System Life Issues

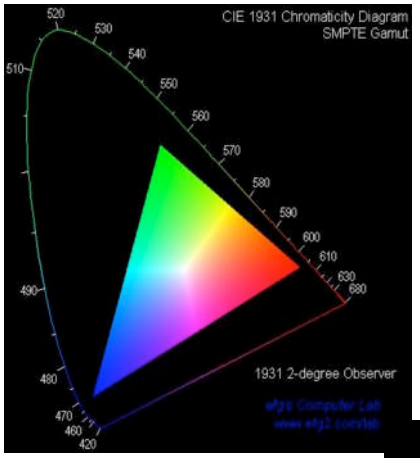
- Impact of long life
  - Care in installation extremely important
  - Regular cleaning and maintenance
  - Availability of spares of same specification

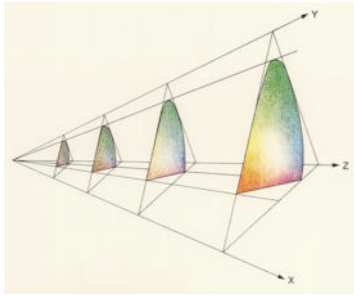


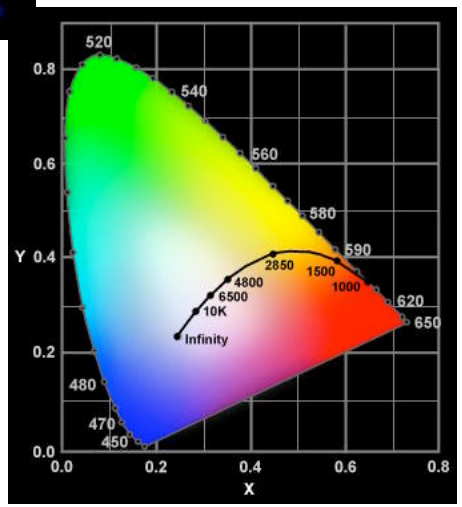


Colour Gamut

- Which 16 million colours?
  - Limited by emission of LEDs
  - Limited by 256 control steps
- Gamut
  - Range of theoretically achievable colours
- Variation of brightness
  - Creates 3rd dimension
  - Increases possibilities

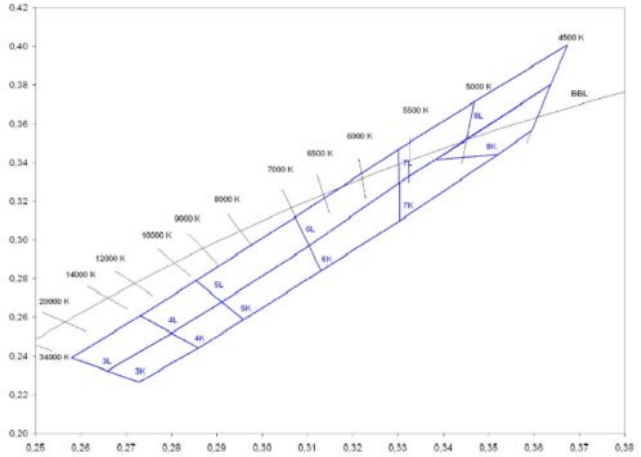


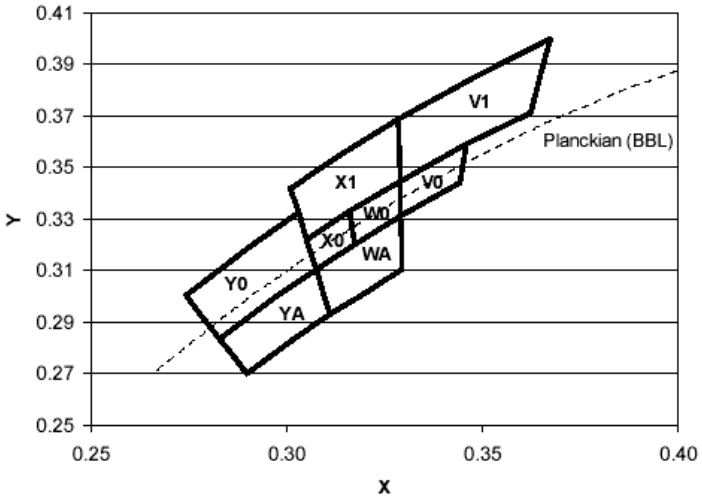




Binning

- What is Binning?
  - LED production inexact
  - Variations selected into production bins
  - Fixture Manufacturers and consultants specify bins
- Variations
  - Different manufacturers have different schemes
  - Difficult to match different manufacturers products
- Critical Issues
  - Direct view of LEDs
  - Few LEDs lighting a surface
  - Adjacent lit areas comparable

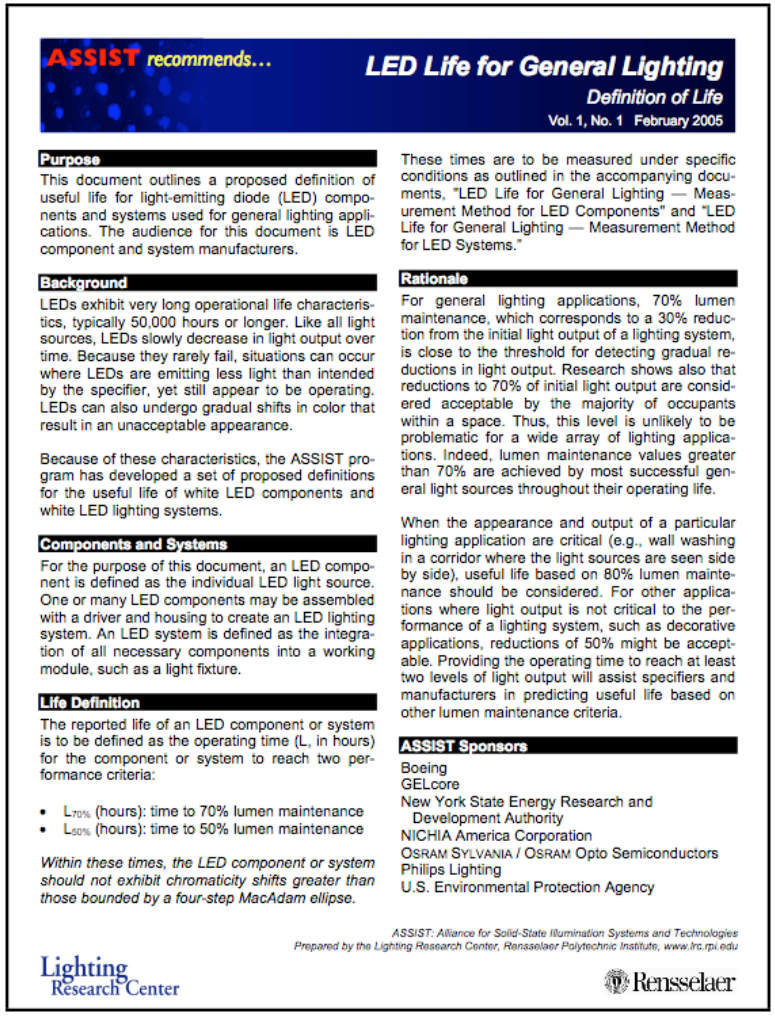




LED Life Issues

- Uncertainty over life in use
  - Manufacturers downgrading LED life expectation
- Life Standards proposed by ASSIST

  (Alliance for Solid-State Illumination Systems and Technologies)
    - 70% of initial lumens for illumination
    - 80% of initial lumens for critical applications
    - 50% of initial lumens for decorative applications
- Life not certain during currency of products



ASSIST recommends...

LED Life for General Lighting

Definition of Life

Vol. 1, No. 1 February 2005

Purpose

This document outlines a proposed definition of useful life for light-emitting diode (LED) components and systems used for general lighting applications. The audience for this document is LED component and system manufacturers.

Background

LEDs exhibit very long operational life characteristics, typically 50,000 hours or longer. Like all light sources, LEDs slowly decrease in light output over time. Because they rarely fail, situations can occur where LEDs are emitting less light than intended by the specifier, yet still appear to be operating. LEDs can also undergo gradual shifts in color that result in an unacceptable appearance.

Because of these characteristics, the ASSIST program has developed a set of proposed definitions for the useful life of white LED components and white LED lighting systems.

Components and Systems

For the purpose of this document, an LED component is defined as the individual LED light source. One or many LED components may be assembled with a driver and housing to create an LED lighting system. An LED system is defined as the integration of all necessary components into a working module, such as a light fixture.

Life Definition

The reported life of an LED component or system is to be defined as the operating time (L, in hours) for the component or system to reach two performance criteria:

- $L_{70\%}$ (hours): time to 70% lumen maintenance
- $L_{50\%}$ (hours): time to 50% lumen maintenance

Within these times, the LED component or system should not exhibit chromaticity shifts greater than those bounded by a four-step MacAdam ellipse.

These times are to be measured under specific conditions as outlined in the accompanying documents, "LED Life for General Lighting — Measurement Method for LED Components" and "LED Life for General Lighting — Measurement Method for LED Systems."

Rationale

For general lighting applications, 70% lumen maintenance, which corresponds to a 30% reduction from the initial light output of a lighting system, is close to the threshold for detecting gradual reductions in light output. Research shows also that reductions to 70% of initial light output are considered acceptable by the majority of occupants within a space. Thus, this level is unlikely to be problematic for a wide array of lighting applications. Indeed, lumen maintenance values greater than 70% are achieved by most successful general light sources throughout their operating life.

When the appearance and output of a particular lighting application are critical (e.g., wall washing in a corridor where the light sources are seen side by side), useful life based on 80% lumen maintenance should be considered. For other applications where light output is not critical to the performance of a lighting system, such as decorative applications, reductions of 50% might be acceptable. Providing the operating time to reach at least two levels of light output will assist specifiers and manufacturers in predicting useful life based on other lumen maintenance criteria.

ASSIST Sponsors

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Philips Lighting
U.S. Environmental Protection Agency

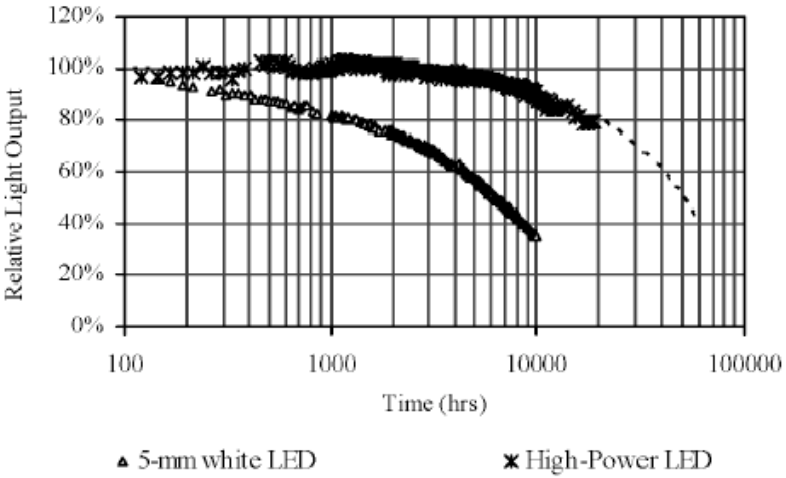
ASSIST: Alliance for Solid-State Illumination Systems and Technologies
Prepared by the Lighting Research Center, Rensselaer Polytechnic Institute, www.lrc.rpi.edu

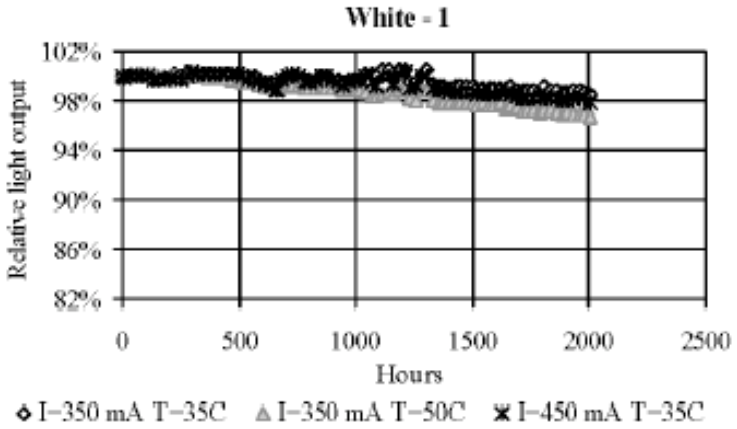
Lighting Research Center

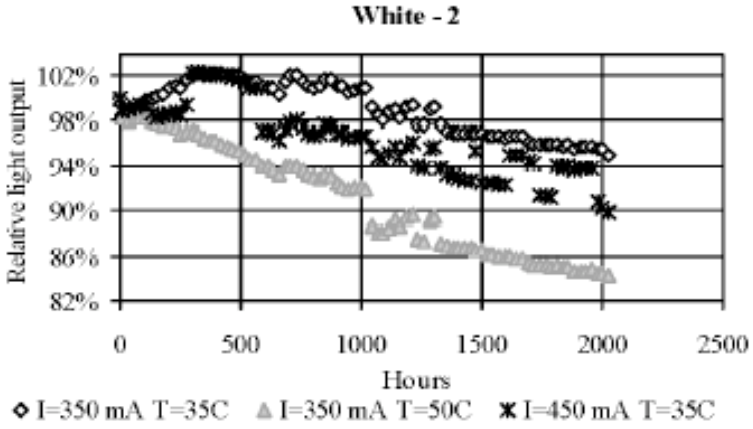
Rensselaer

Life Research

- Rensselaer Polytechnic
  - Experiment started in 2001
  - Latest report 2004
  - 18,000 hours at room temperature
  - Light output 80% of initial lumens
- New study for competeing power LEDs
  - White 1 single die
  - White 2 multi die

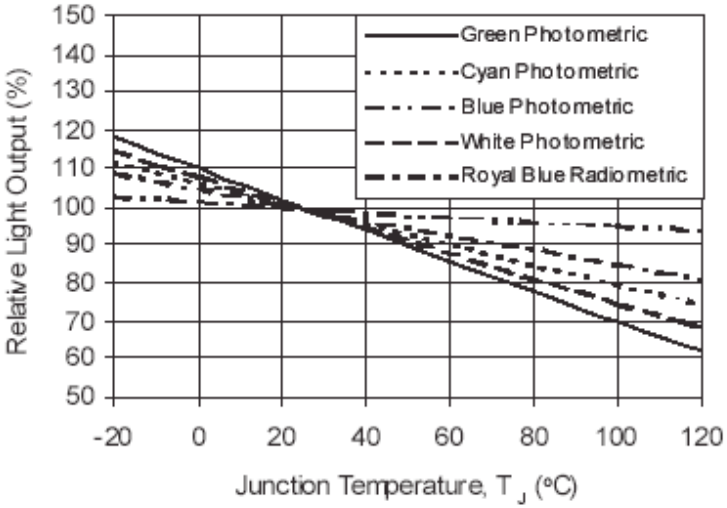


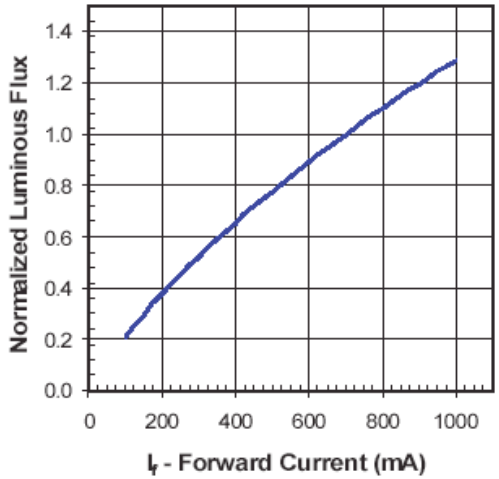




LED life factors

- 3 linked factors
  - Forward current
  - Lumen output
  - Junction temperature





Manufacturer's claims

- Lumileds
  - 50,000 hours to 70% initial Lumens at junction temp of 90°
- GE, Gelcore
  - 20,000 hours to 70% initial Lumens for 1W and 4 W packages at room ambient of 25°C on 4 Watt heat sink
- Philips
  - 34,000 hours to 70% initial Lumens
- Philips producing T5 Fluorescent with 42,000 hour life to 80% initial lumens with steep failure curve at end of life.

Luxeon K2

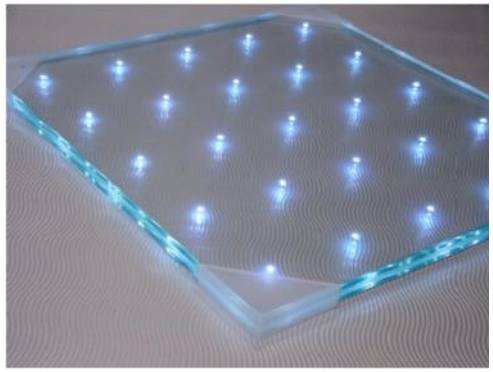
- New Approach
  - 1 LED many applications
  - Different input different output
  - Variable Light output / life / temperature
- Robust Package
  - 185°C Junction Temperature
  - Manufacture with production soldering
  - Operate in Higher ambient temperatures
- Specification Issue
  - How do you ensure correct performance?

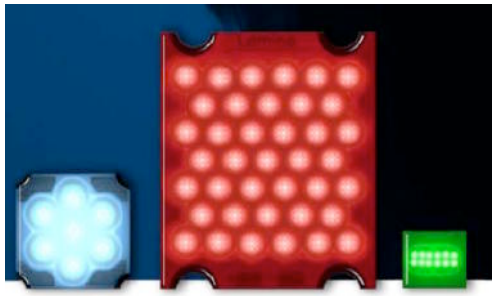
Energy Issues

- Low Energy?
  - = low output
- Actual Efficiency
  - Manufacturer data misleading
    - 2.3W Osram Dragon LED 25Lm = 11 Lm/W stated 21 Lm/W (optical lumens)
    - Osram Linear 30W 405Lm = 13.5 Lm/W
    - Luxeon 1W 3000K stated 20 Lm = 20 Lm/W
    - Luxeon 1 W 5500K stated 31 Lm = 31 Lm/W
    - Luxeon 111 65Lm @ 700mA = 32.5 Lm/W
    - Luxeon 111 80Lm@ 1000mA=20.5 Lm/W
  - Comparison with Incandescent
    - 100W 'A" lamp 1360Lm = 14Lm/W
    - 50W TH Capsule 910Lm = 18.2Lm/W
    - 50W TH IRC capsule 1200Lm = 24Lm/W

- Energy Efficiency requires consideration of total heat load

Technical Options



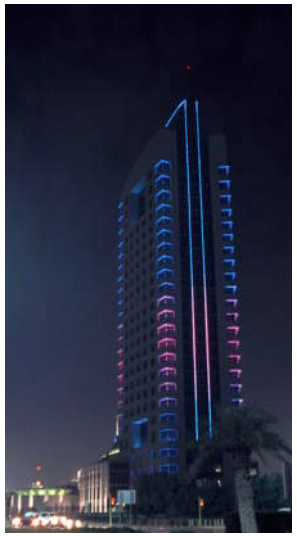


Key Specification Questions

- Fixture manufacturers
  - What LED used?
  - What is design lumen output?
  - What is design junction temperature?
  - What is life to 80% 70% or 50% of output?
  - What bin / bin range are you using for this project?
  - Are you directly consulting with LED manufacturer?

Conclusions

- Understand the difference between LEDs and lamps
- Choose appropriate technology
- Specify clearly and in detail
- Follow supply process through
- Expect problems
- Plan and allow time
- Be flexible and patient in programming
- Consider implications of product life



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lighting design

Credits:

For KSLD

Keith Bradshaw
Tapio Rosenius
Kevan Shaw

Architects

SSH Kuwait
WZMH Toronto

Equipment

TIR lightpipe
Supervision
Colorkinetics
ETC theatrical controls

Graphics and information for presentation

Rensselaer Polytechnic / ASSIST
Luxeon
Osram
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