Trends in Manufacturable Designs for SSL Luminaires

Nikhil Taskar

WAC Lighting

Desirable Luminaire Attributes

- Application Efficacy
- Occupant Visual Comfort
  - Color Consistency
  - Application Specific Beam/Photometric Control
    - Illuminance Gradients, Contrast
  - Glare Control
- $/kLm

Hybrid Integration of Light-Engine Modules

Example :

Direct / Indirect……. Pendant and Task-Ambient Luminaires

- High-Luminance Spot/Linear Light-Engine
  - Directional
  - Indirect
- Low-Glare Area Source…….Edgelit LED Panel,……. OLED
  - Direct (eg. Task) or Indirect (eg. Wallwashing)
  - Controlled Beam/Photometric
  - Low Veiling-Glare
- Diverse Form-Factors, Thermal-Management

Manufacturable Designs Enabling…….

- Connectivity within the Luminaire
  - Electrical
  - Mechanical / Structural

- Adaptability / Configurability
  - Factory
  - Field
    - Reduce inventory count
    - Application specific tuning

- Ability to tune/vary the Luminaire's
  - Indirect/Direct ratio……..Photometric……Aiming
  - Series - Parallel ……Electrical Interconnections

Implementation Pathway

- Structural "Network" ……"Lattice"

- Functionally
  - Embedded Electrical Connectivity
  - Switching / Routing Capability

- Modular Assembly of "Building-Blocks"
  - Rail / Track
  - Joints / Junctions

  "Ball-And-Stick" model

- Regulatory Classification Risk ……?

Implementation Pathway – Manufacturing Implications

- Automation with Vision Systems

- Departure from
  - Sheet-Metal Work…….Metal-Bending……
  - Wiring

- Extruded / Molded "Building-Blocks" (Rail/Track, Joint/Junction)
  - Integrated Conductors, Connectors, Contacting Schemes……
  - Snap-Fit
  - Diverse Material Systems

- klm/kg Figure-Of-Merit
  - Sustainability, Cost……

Implications for Manufacturing of OLED and LED Flat-Panel Area Sources

- Modules with Integrated Connectors
  - Electrical, Mechanical contacts
- Drive Current Rating Compatibility of OLED with LED Modules
- Vf Binning for Flat Panels
  - Series – Parallel connections in Luminaire
- 2 SDCM Chromaticity Binning for OLEDs
- Back-End Integration of Light-Management Films/Layers
  - Application-Specific Beam/Photometric Control without Compromising Uniformity of Color-Over-Angle
- $/klm for OLED

Integration of Drive, Sense & Control Electronics with Connectivity to EMS

Motivation:

Potential 50%-70% Reduction in kW Demand and kWh Consumption with Automated Demand-Response (ADR) capable Energy Management System (EMS)

- Modular Integration of Functional-Blocks
- Shared/Common Power-Supply Block
- Single Module with Board Level Partitioning
- Mother – Daughter Boards
- In-Line Testing of Functional Boards
- Firmware Upload + Calibration + Test
- Trade-Off……Application-Specific Firmware Upload in Field

In-Line Electro-Optic Testing

- Flexibility with respect to the Stage of Assembly/Integration of Light-Engine (s) into the Luminaire

- Correlation between In-Line Monitored Parameters and Application-Specific Performance

- Secondary Binning / Sorting

Optics & Light-Management Components

- 3-D Freeform Optics - Application and Emitter Specific
- Manufacturing Tolerances
  - Surface Roughness; Curvature
- Planar Optics
  - Surface Microstructure Features; Size & Form-Factor Tolerances
- Foundry Model….?
  - Domestic Manufacturing Base