Next Generation Luminaire Manufacturing

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Topics of Discussion (Food for thought …)

- History of Lighting Manufacturing
- Design for Mfg: Anatomy of a Luminaire
- LED Lighting Manufacturing Process
- Discrete → Integrated Manufacturing Mindset
- Potential Savings: Minimizing Redundancy
- Case Study: Thick-Film Integrated Manufacturing
- Additive Manufacturing: Print on Demand
- Summary: DOE Funding Recommendations
History of Lighting Manufacturing

1000’s: Candle Manufacturing

Ca 1816: Coal Gas Producing Station

Mid-1800’s: Clean glass, the start of Daylight Harvesting

Early 1900’s: Filament-making Plant for electric lighting

Mid-1900’s: Incandescent Lamp Mfg

1960’s: Fluorescent Lamp Mfg

History of Light & Lighting
Prof. D. DiLaura/Used with Permission

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Design for Manufacturing: Anatomy of a Luminaire

- Wiring Harness
- Ballast/Driver
- Lighting
- Housing/Fixture
- Controls & Comm
- Light Source
- Trim
- Heat Sink
- Socket/Board
Luminaire Manufacturing Overview

Fabrication
- Raw coiled or sheet metal
- CNC turret presses
- CNC Press brakes
- Manual Press brakes
- Progressive presses

Paint Line
- Paint capability
  - Matte white
  - High Reflectance white
  - Color booth
  - Variable Speed
  - Stainless Steel Polish

Assembly
- Cell assembly standard
- Typically reconfigurable
- In-Line testing
- Photometrics
- Electrical characterization
Luminaire Manufacturing Processes

**Progressive Process**
- Coiled Metal
- Progressive Press
- Formed Part

**CNC Process**
- Sheet Metal
- Turret
- Blank
- Brake
- Formed Part

**Weld & Paint**
- Formed Parts
- Weld
- Paint
- Ready for Ass’y

**Luminaire Assembly**
- Fixture Ass’y
- Ballast/Driver Ass’y
- Test
- Pack-out
Discrete → Integrated Mfg Mindset

**Music**
- Mechanical
- Hardware

**Digital Music**
- Electrical
- Software

**Typewriter / Print**
- Analog

**Word Processing**
- Mechanical → Electrical
- Analog → Digital
- Hardware → Software

**Camera / Film**
- Analog

**Mobile Device**
- Mechanical → Electrical
- Analog → Digital
- Hardware → Software
Potential Savings: Minimizing Redundancy

**Electronics**
- Enclosure
- Substrate
- Wiring

**Luminaire**
- Housing
- Substrate
- Wiring

**Controls**
- Enclosure
- Substrate
- Wiring
Case Study: Thick-Film Integrated Mfg

Thick-film additive manufacturing process to print circuits on luminaires

- Thermal efficiency
- Energy efficiency
- Less aluminum = Lower cost
- Flexible manufacturing / supply chain… Print on demand
- Fewer components, less assembly

Mount LEDs and electronics on housings

(100% size reduction
60% energy savings
>20% cost out

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Additive Mfg: Print on Demand

Subtractive Process

Additive Processes

Typical PCB Mfg “Subtractive” Process

- Metal
- 3D Optics
- Circuits
- Emitters
- Detectors
- Interconnects
Summary: DOE Funding Recommendations

- Core LED
- LED Driver Electronics
- LED System Manufacturing Processes
  - Cost-out: Integration … minimize redundancy
  - Additive Mfg: Only add what is needed
  - Design for Mfg: Interconnectivity
- Leverage the benefit of the SSL source
  - Digitization
  - Control
  - Communication