Next Generation Luminaire Manufacturing

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DOE R&D Workshop

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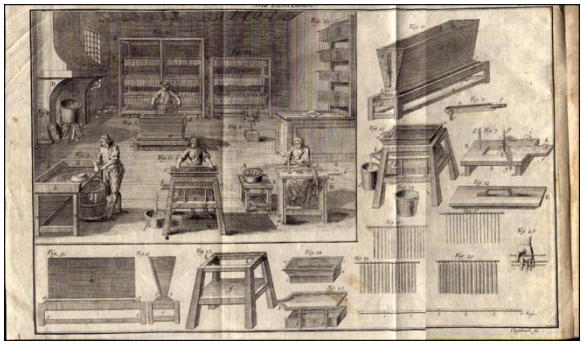
Powering Business Worldwide

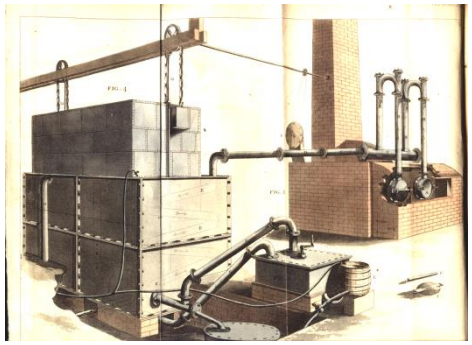
Topics of Discussion (Food for thought …)

- 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

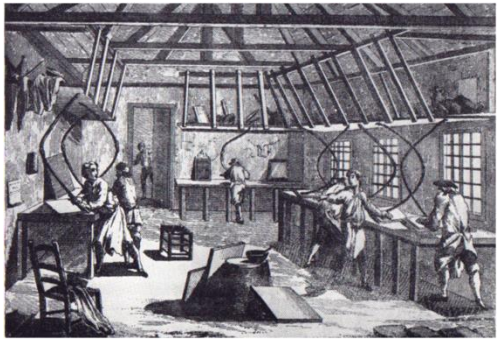
History of Lighting Manufacturing



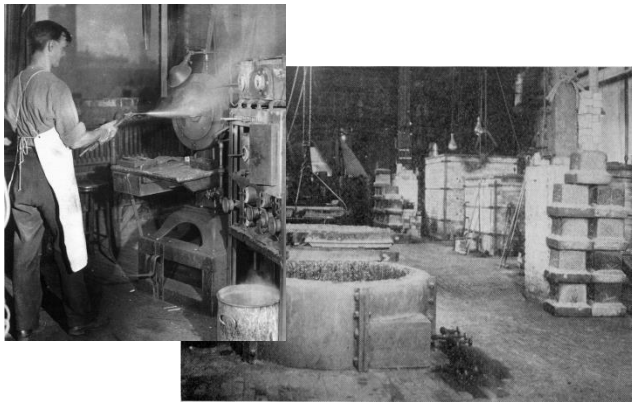
1000's: Candle Manufacturing



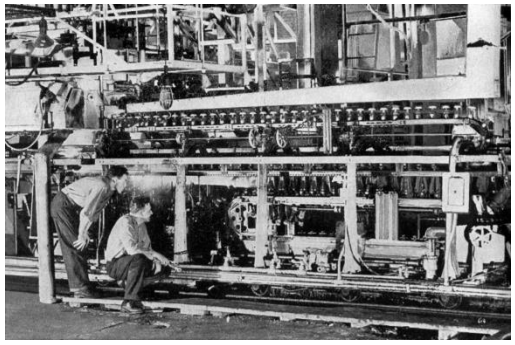
Ca 1816: Coal Gas Producing Station



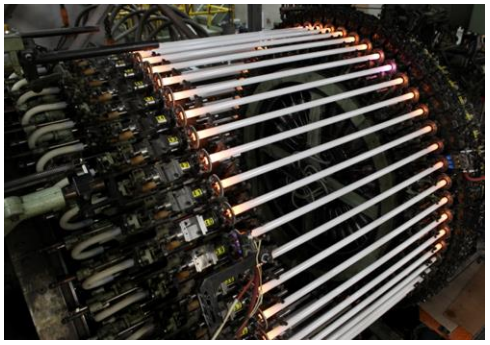
Mid-1800's: Clean glass, the start of Daylight Harvesting



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

LFL Manufacturing Image
Provided by GE

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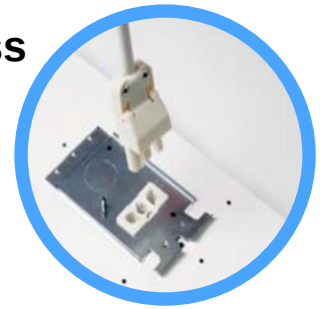
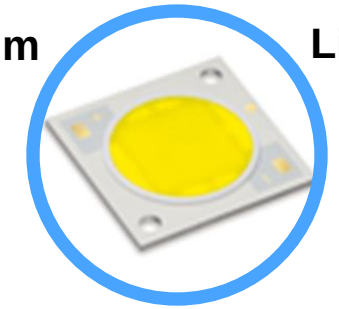
Design for Manufacturing: Anatomy of a Luminaire

Wiring Harness



Controls & Comm

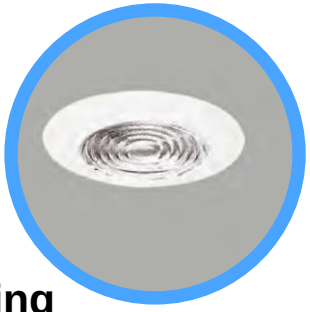
Light Source



Ballast/Driver

Housing/ Fixture

Trim



Lensing

Socket/Board

Heat Sink

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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

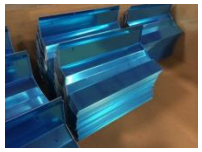
- Cell assembly standard
- Typically reconfigurable
- In-Line testing
  - Photometrics
  - Electrical characterization

Luminaire Manufacturing Processes

Progressive Process

Coiled Metal — Progressive Press — Formed Part



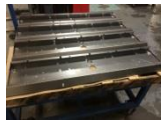


CNC Process

Sheet Metal — Turret — Blank — Brake — Formed Part

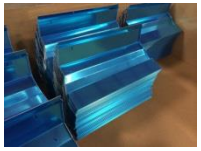
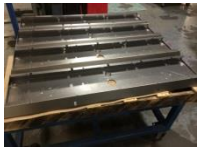






Weld & Paint

Formed Parts — Weld — Paint — Ready for Ass'y


Luminaire Assembly

Fixture Ass'y — Ballast/ Driver Ass'y — Test — Pack-out

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Discrete → Integrated Mfg Mindset

Music

Digital Music

Typewriter / Print

Word Processing

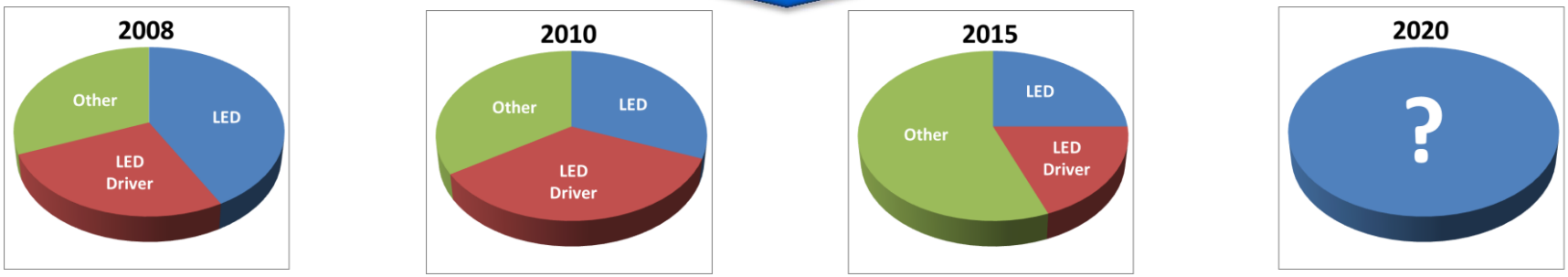
Camera / Film

Mobile Device

- Mechanical → Electrical
- Analog → Digital
- Hardware → Software

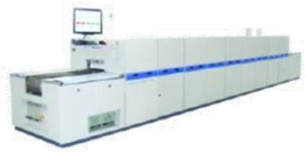
Potential Savings: Minimizing Redundancy

Electronics	Luminaire	Controls
• Enclosure	• Housing	• Enclosure
• Substrate	• Substrate	• Substrate
• Wiring	• Wiring	• Wiring



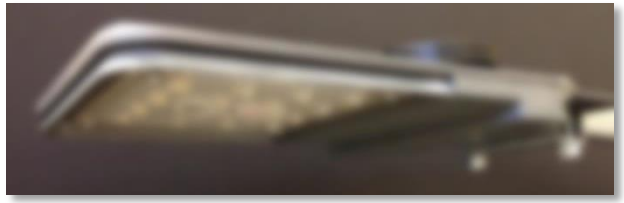
Case Study: Thick-Film Integrated Mfg

Thick-film additive manufacturing process to print circuits on luminaires



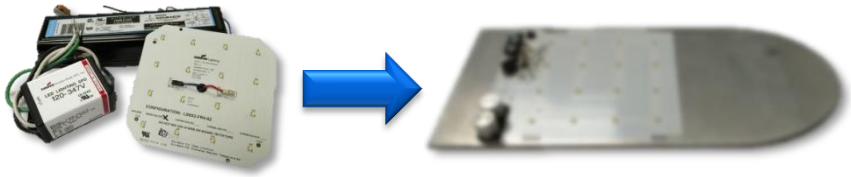
- Thermal efficiency
- Energy efficiency
- Less aluminum = Lower cost
- Flexible manufacturing / supply chain… Print on demand
- Fewer components, less assembly

OVH HID



Thick-Film LED

Mount LEDs and electronics on housings

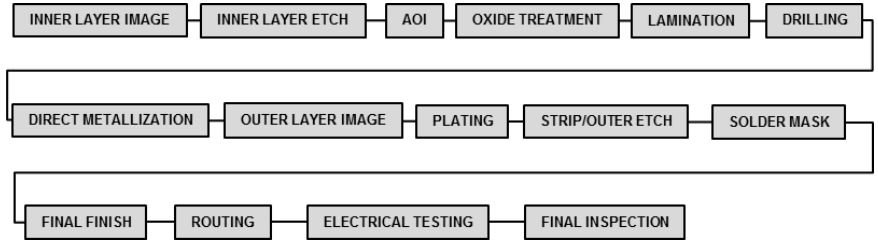


- **90% size reduction**
- **60% energy savings**
- **>20% cost out**

(DOE Proj. NO. DE-EE0006260)

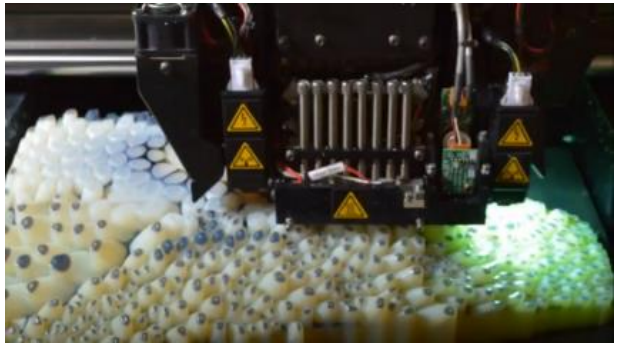
Additive Mfg: Print on Demand

Subtractive Process



Typical PCB Mfg "Subtractive" Process

Additive Processes



- Metal
- 3D Optics
- Circuits
- Emitters
- Detectors
- Interconnects

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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


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