

Manufacturing Methods for Connected Lighting Luminaire

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DOE R&D Workshop

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Powering Business Worldwide

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Discussion Topics

- EATON Lighting : Who & What we do?
- Efficacy Roadmap
- Market Drivers & Barriers
- Luminaire Manufacturing Methods
- Manufacturing Process
- Manufacturing future : Additive Mfg
- Recommendations

EATON Lighting : Who & What we do?

LED's

Driver

Optic Design

Photometric Qualification

Application Layouts

UL Certification

DLC Certification

Energy Star

Cast Products

Metal fabricators

Plastic Molding

DISTRIBUTORS

UTILITY Channel



Luminaire



Dept. of Transportation

Lighting Designer's

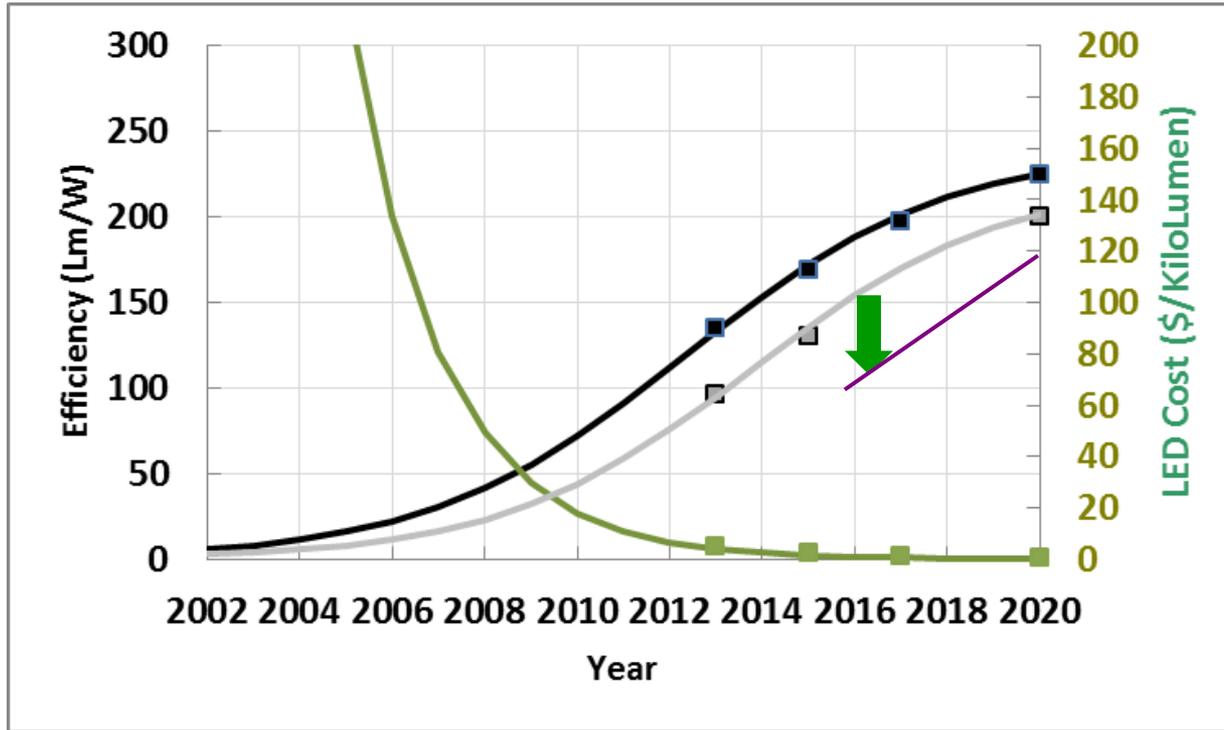
CONTROLS

IOT

Rubber meets the Road!

Picture Source:
<https://henrykh.wordpress.com/2010/06/16/rubber-meets-the-road-recovering-to-stake/>

Luminaire : Cost / Efficacy Roadmap



DOE Solid-State Lighting Research and Development
Multi-Year Program Plan, April 2014.

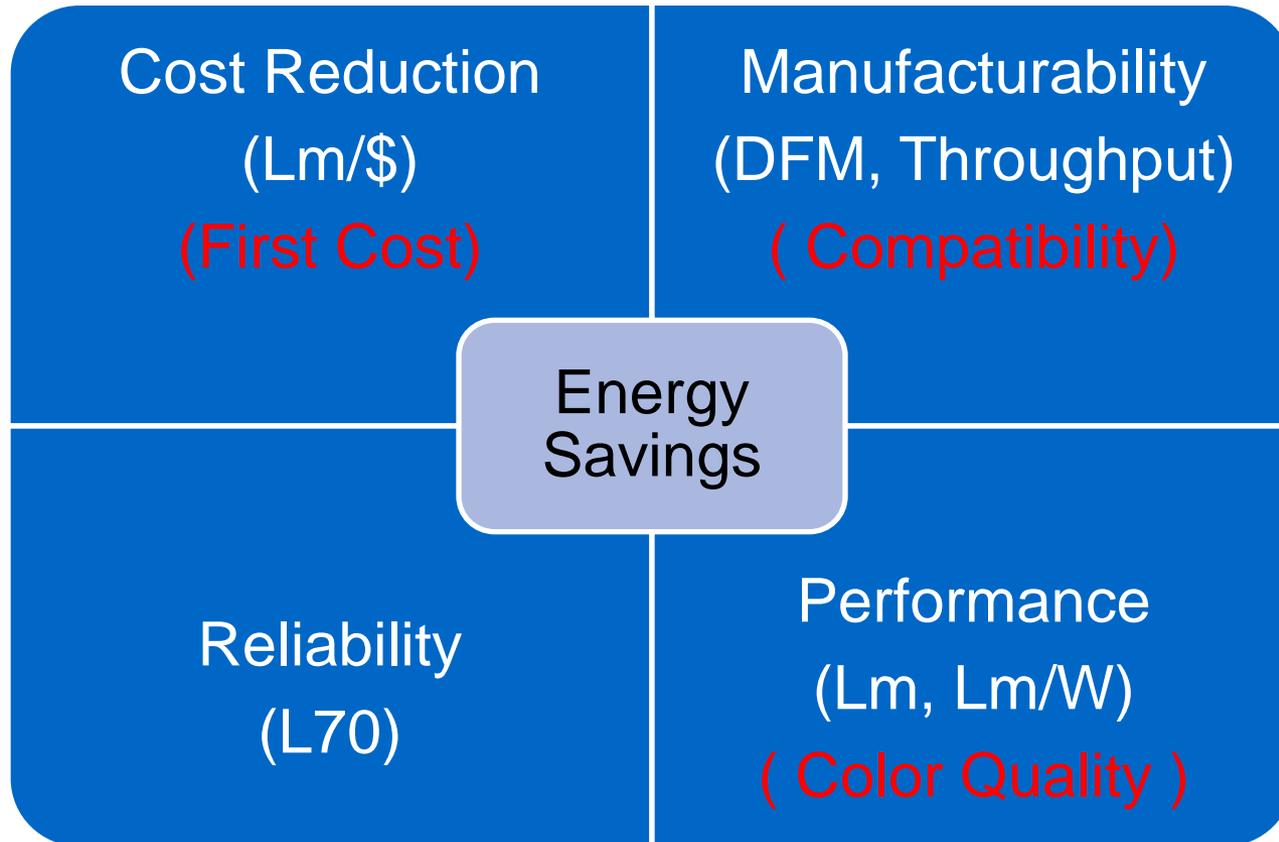
*Fit lines added

Black Line = LED

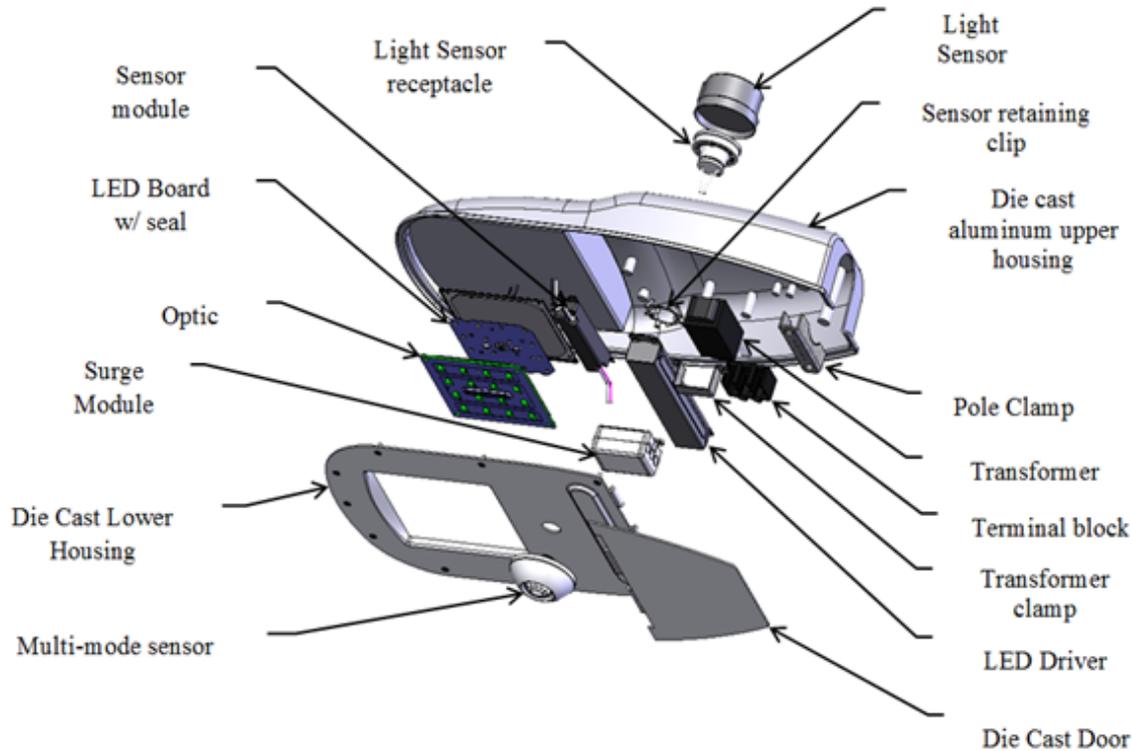
Grey Line = Luminaire

Brown Line = Controlled Luminaire (added)

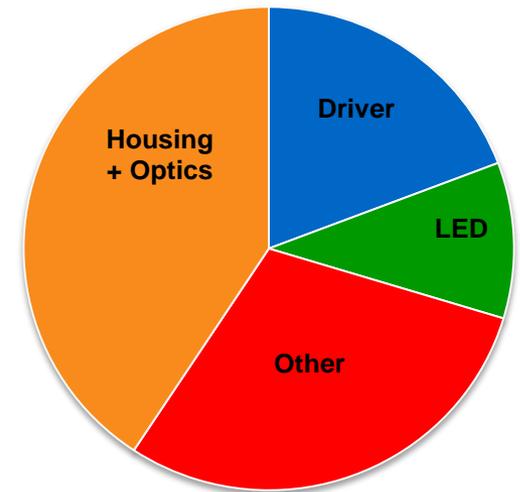
SSL Market Drivers / Barriers for Adoption



Luminaire Assembly



Luminaire Cost Breakdown



Manufacturing Process & other are significant contributors to Total cost!

Luminaire Manufacturing Methods

Casting



<http://www.jepsculpture.com/art/ben-casting.jpg>

- Higher Cost
- Complex shape Limitation
- Good Structural & Thermal properties
- Painting needed
- Aesthetic oriented designs

Molding

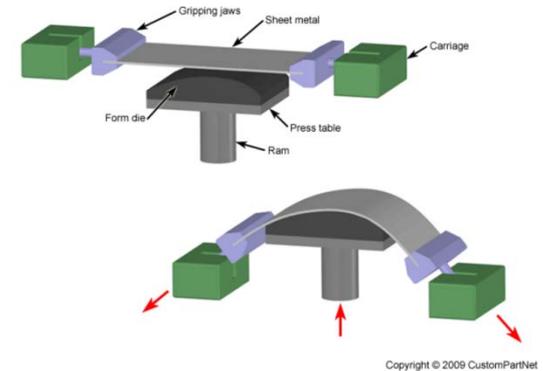


<http://www.omgtestserver.com/gms2016/wp-content/uploads/2011/09/new2.jpg>

- Lower Cost
- Good for optic needs
- Pre-painted parts
- Poor Thermal conductivity
- Aesthetic oriented designs

Subtractive Process!!

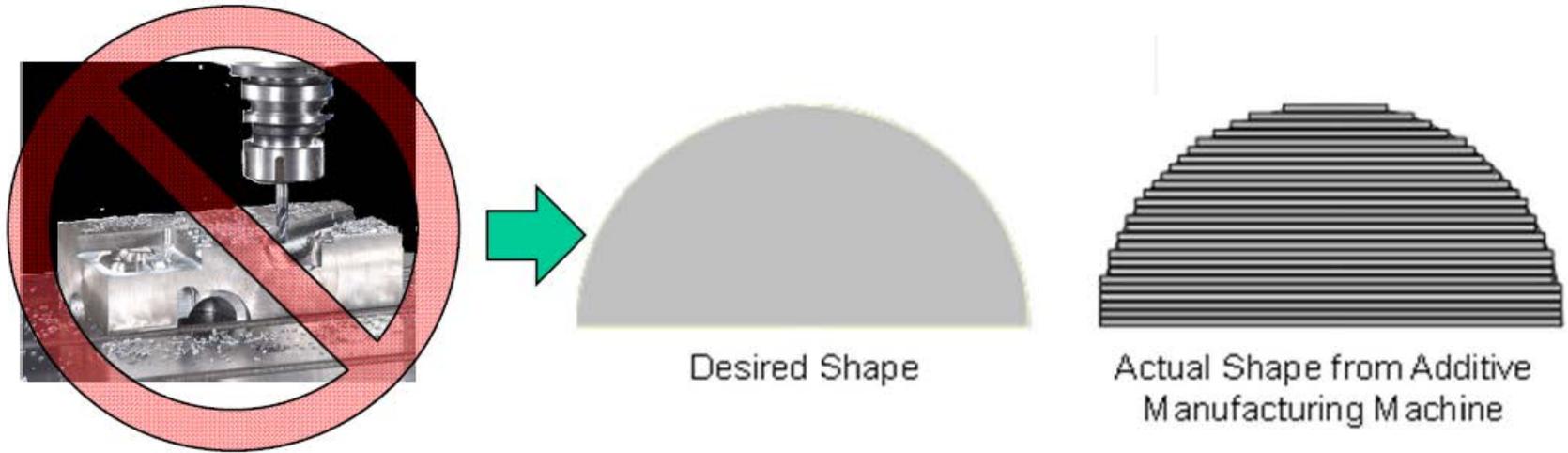
Sheet metal Fabrication



<http://www.custompartnet.com/wu/images/sheet-metal/stretch-forming.png>

- Lowest Cost
- Pre-painted parts
- Poor Thermal conductivity

Future Manufacturing Process

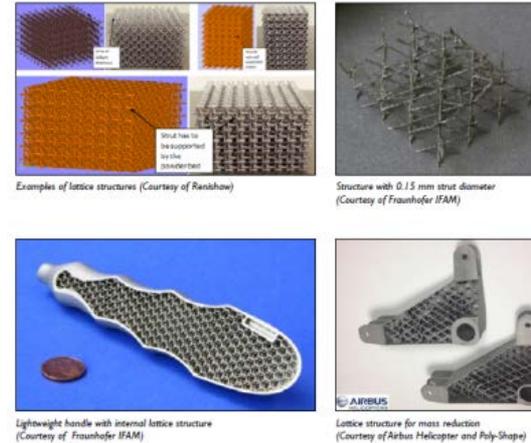
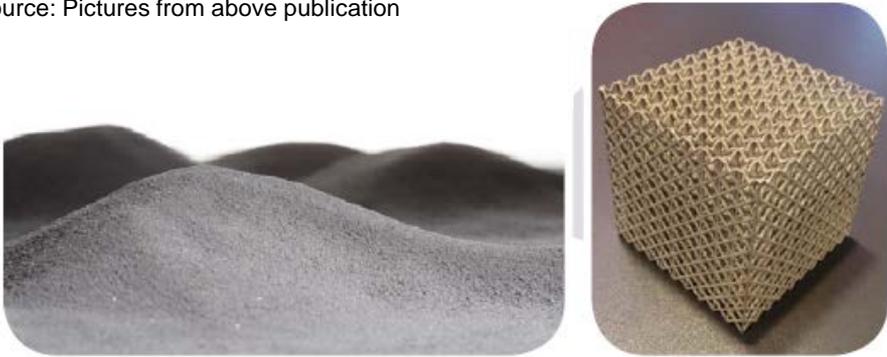


Future Processes: No Material Wastage

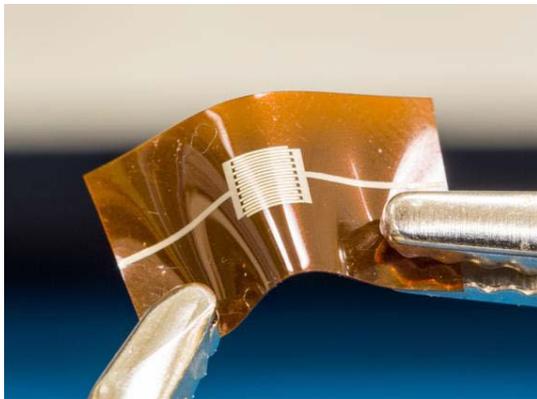
Future Manufacturing Process

3D Metal / Plastic Printing

Source: Pictures from above publication



Printed Electronics



Source: Georgia Tech presentation

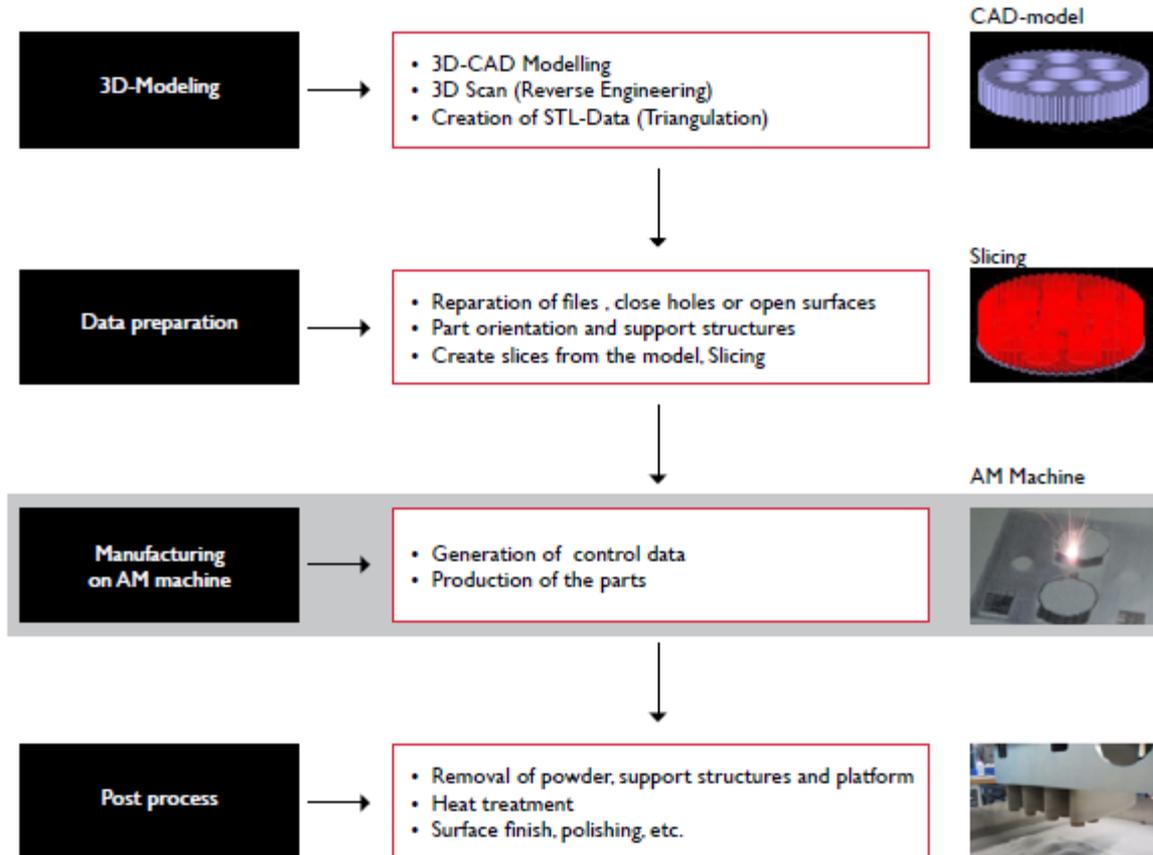
Printed Optics



<https://3dprint.com/88316/wacker-3d-printed-silicone/>

Additive Manufacturing : Metal, Plastic, Printed Electronics.....

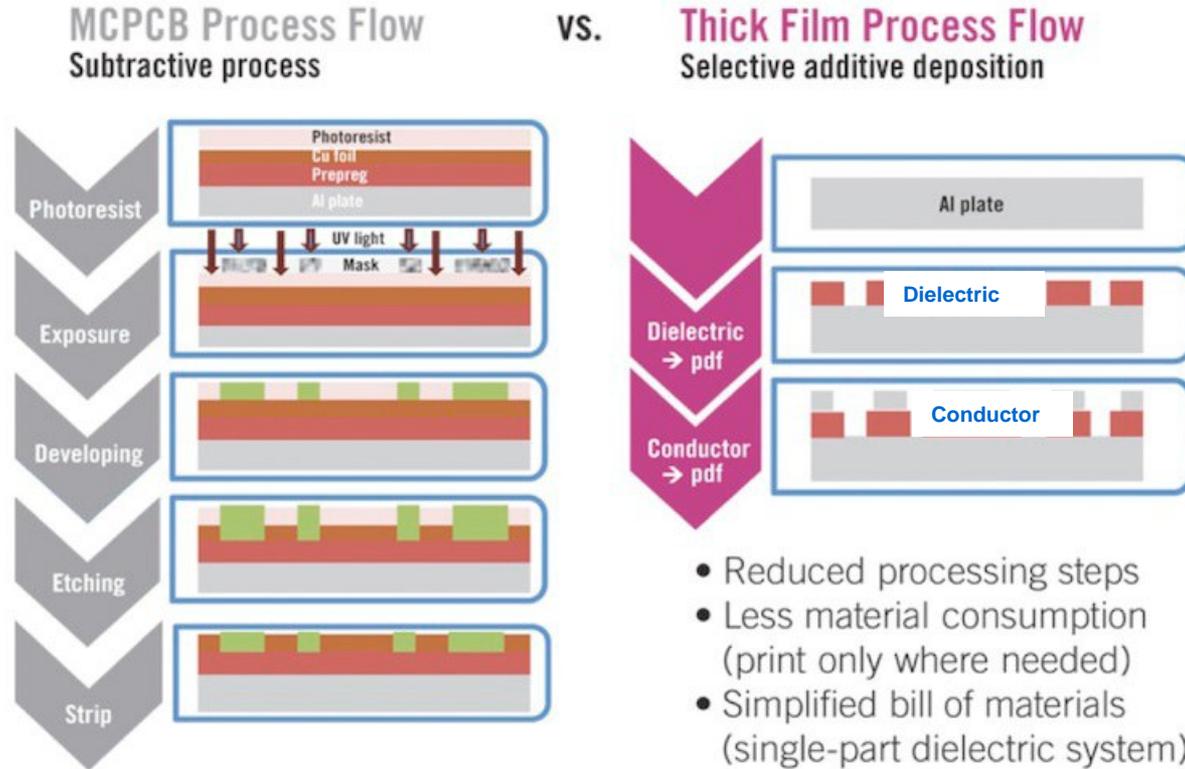
Eliminate Manufacturing Redundancy



Summary of process steps (Courtesy of Fraunhofer)

Quicker to Market & Low manufacturing cost!!

Electronic Circuit Board : Manufacturing



- Reduced processing steps
- Less material consumption (print only where needed)
- Simplified bill of materials (single-part dielectric system)
- Quick and inexpensive design changes
- Inert glass/metal system- No flammability issues

Picture Source:

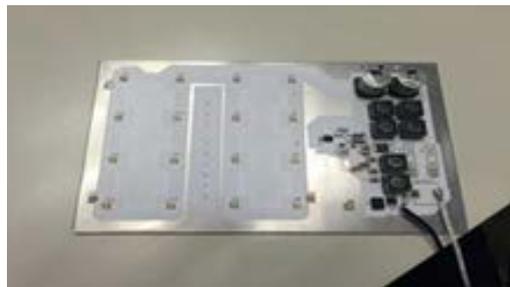
https://www.led-professional.com/products/mechanics/heraeu-s-celcion-r/@_images/05435290-d2f5-4a63-b4f2-76e1ae9177ea.jpeg

DOE Funded Project : Thick-Film Integrated Mfg

Thick-film additive manufacturing process to print circuits for luminaires



Thick Film Lab



Integrated Module



Thick-Film LED

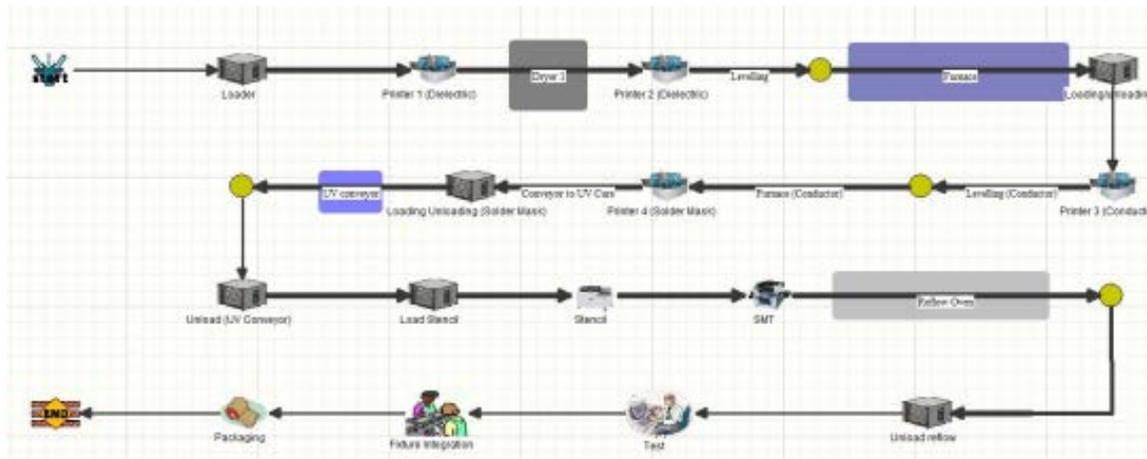
(DOE Proj. NO. DE-EE0006260)

Future Manufacturing Process

Print Housing

Print Electronics

Print Sensors



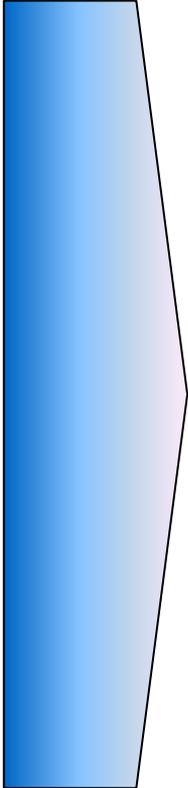
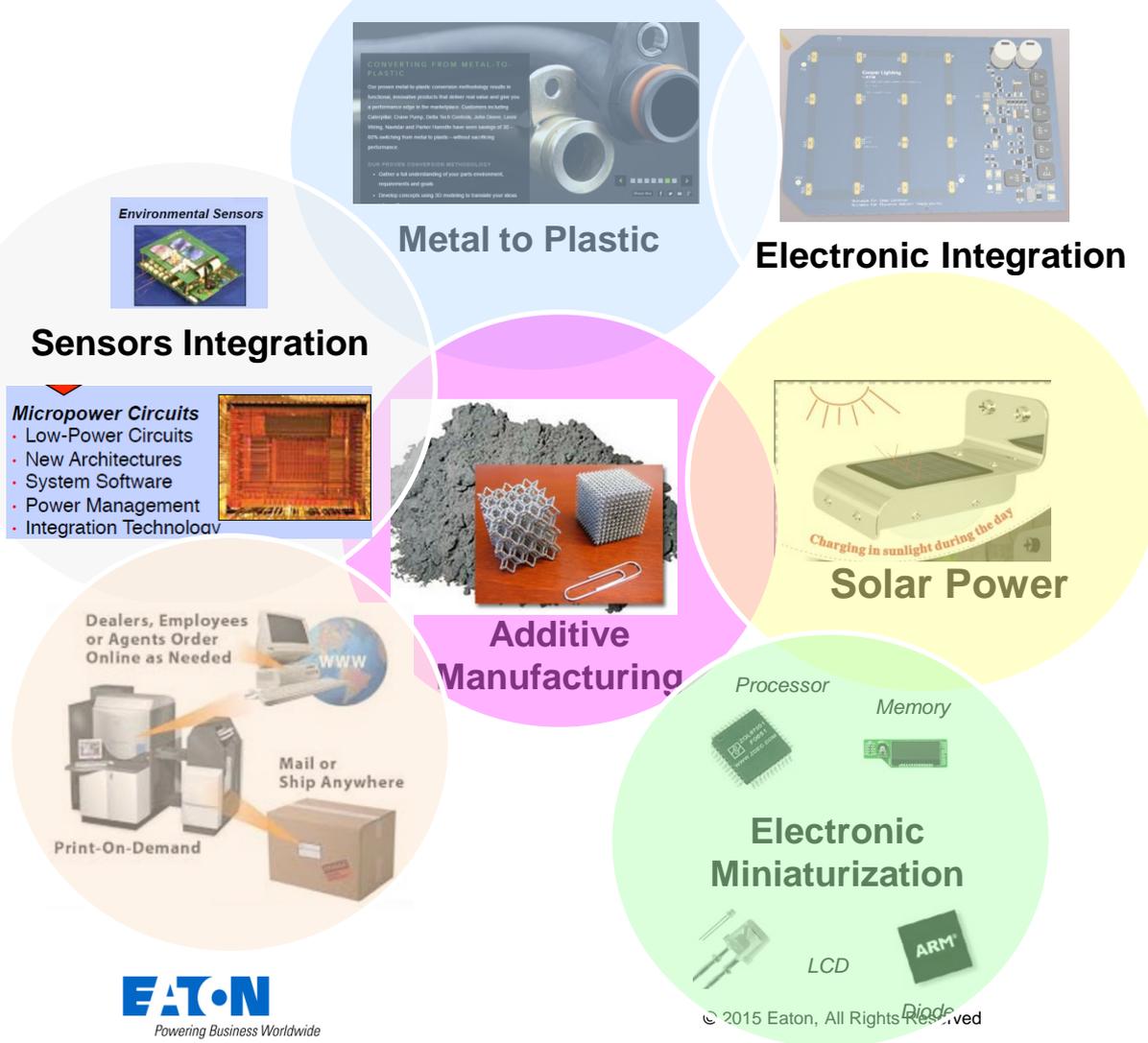
Print Optics

Print LED's

Interconnect & Assemble

Additive Mfg initiative ⇒ *Print on Demand*

Print on Demand Manufacturing Process for Connected Lighting...



Fixture of Future:

- Low Cost
- High Efficacy
- High Reliability.
- Aesthetic
- Solar Powered
- Print on Demand
- Sensors Integrated
- Controls Integrated.
- Daylight control
- Light Weight
- High Efficient

Solution : Integration

Recommendation to DOE

PC / Mobile Industry



Module based (past)

Integrated construction (future)



Lighting Industry

Fund Projects to encourage :

Integrated Solutions + Additive Manufacturing

Thank You!



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