The Latest in AM, and how to get small Manufacturers to use it...

- Dave Pierson
- MAGNET/ America Makes
Additive Manufacturing De-risking …

AMERICA MAKES MAGNET - MEP EMBEDDING PROGRAM APPLICATION EXAMPLES
America Makes

Accelerating the adoption of additive manufacturing technologies in the United States to increase domestic manufacturing competitiveness.

3D printing has the potential to revolutionize the way we make almost everything.

We collaborate to accelerate additive manufacturing technology in the US.
Our first priority is making America a magnet for new jobs in Manufacturing...

The next industrial revolution in manufacturing will happen in America.

...3D printing that has the potential to revolutionize the way we make almost everything...

We can get that done.”

— President Barack Obama, 2013 State Of The Union Address
Public / Private Partnership
America Makes has substantial federal investment, private industry and academic investment.

Multi-Agency Collaboration
Partnership between industry, government and universities, led by the Defense-wide Manufacturing S&T team.

Membership
Innovation facility in Youngstown, Ohio with 213 members. We continue to grow.

Operations
We are operated by the National Center for Defense Manufacturing & Machining (NCDMM)
Team NEO additive Cluster

Vision
• By 2023, Northeast Ohio will be recognized as a leader in: Design and engineering for additive manufacturing
• Using additive manufacturing for productivity enhancements
• AM entrepreneurial investment and growth
• AM materials innovation
• Attraction of significant investment related to the core activities of America Makes
Additive in a box

How did FDM compare with traditional tooling methods for Oreck?

<table>
<thead>
<tr>
<th>Method</th>
<th>Tool Production Time</th>
<th>Tool Cost</th>
<th>Tool Production Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional CNC</td>
<td>7 days</td>
<td>$250</td>
<td>30 days</td>
</tr>
<tr>
<td>FDM</td>
<td>3.5 hours</td>
<td>$55</td>
<td>1 day</td>
</tr>
<tr>
<td>SAVINGS</td>
<td>3.5 days (50%)</td>
<td>$95 (79%)</td>
<td>29 days (97%)</td>
</tr>
</tbody>
</table>
Applications

Machines

Materials

Value

Applications
Engagement strategies

- Initial meeting with short presentation on Additive Manufacturing.
- Factory floor walkthrough with key players.
- Presentation on Additive application examples
  - Parts, Real parts
- Post visit deliverable
  - Additive Assessment.
  - Project engagement, T&M
Cad Capabilities……

- Management strategy:
  - Reactive
  - Tactical
  - Strategic
Let’s Drill Down

Pioneering NanoParticle Jetting™ technology
Using NanoParticles in a Liquid Dispersion
Lego Block

- Design Control
- Material properties
- Geometry complexity
- Production Volume
- Mass Customization
- ROI
- Cost
- Time
Printed parts/Topology Optimization
Design for Additive Manufacturing
A quick glimpse..
Life cycle energy use comparison of machining and EBM of a Ti aircraft bracket

**Conventional Machining - Buy-to-Fly Ratio 8:1**
- Mill Product (slab, billet, etc.)
- Secondary Processing (8.72 kg)
- Machined Product
- Final Processing
- Finished Part

**Additive Manufacturing - Buy-to-Fly Ratio 1.5:1**
- Powder
- Electron Beam Melting (EBM)
- Final Processing (0.38 kg)
- Finished Part

<table>
<thead>
<tr>
<th>Process</th>
<th>Final part (kg)</th>
<th>Ingot consumed (kg)</th>
<th>Raw mat’l (MJ)</th>
<th>Manuf (MJ)</th>
<th>Transport (MJ)</th>
<th>Use phase (MJ)</th>
<th>Total energy per bracket (MJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machining</td>
<td>1.09</td>
<td>8.72</td>
<td>8,003</td>
<td>952</td>
<td>41</td>
<td>8996</td>
<td>217,949</td>
</tr>
<tr>
<td>EBM (Optimized)</td>
<td>0.38</td>
<td>0.57</td>
<td>525</td>
<td>115</td>
<td>14</td>
<td>76,282</td>
<td>76,937</td>
</tr>
</tbody>
</table>

Source: MFI and LIGHTEnUP Team
Challenge
Take a Legacy 6-Part Injection Mold Assembly Design and Create a Better Product that is More Durable, Lower Cost, and Works with Bleach & Sanitizers?
6-Part Nozzle Design for Injection Molding

- Vitamix’s Concerns with Molding:
  - High Tooling Cost
  - Long Lead Times for Tooling
  - Assembly with Small Parts
  - Design for Molding

- Vitamix’s Concerns with AM:
  - Reliability
  - Durability
  - Critical Small Hole Features
  - Threads to Mating Molded Part
  - Resistance to Bleach, Detergents & Sanitizers
  - Part Cost
6-Part Nozzle Design Testing

- Tested 6-Part Design in RPU
  - Parts when assembled performed similar to the legacy 6-part molded nozzle
  - Quick turnaround from design to parts
  - Finish & accuracy were really good which allowed for ease of assembly and assembly to other molded components.
  - Small critical holes were inconsistent and required special cleaning with wire to ensure thru-hole
  - Threads required special cleaning
  - Multiple assemblies required multiple runs due to 6-part design
- Summary of Results:
  - Material & Process were an option for production
  - Concerns were reduced for Durability & Reliability
  - Concern were reduced on hole and threaded features
  - Concerns with use with Bleach, Detergents & Sanitizers
  - Concerns with part cost and production feasibility due to projects volumes
First Iteration Single Part Nozzle Re-Design for AM

- Vitamix’s Single Part Advantage
  - No Tooling Costs
  - No Tooling Lead Times
  - No Assembly with Small Parts
  - Design Freedom
  - Reduced MOQ & Inventory Burden

- Vitamix’s Production Concerns
  - Reliability & Durability
  - Critical Small Hole Features
  - Threads to Mating Molded Part
  - Bleach, Detergents & Sanitizers
  - Part Costs
Optimized Single Part Nozzle Design for DLS

- **Vitamix’s Optimized Single Part Advantage**
  - No Tooling Costs
  - No Tooling Lead Times
  - No Assembly with Small Parts
  - Design Freedom
  - Reduced MOQ (Minimum Order Quantity) & Inventory Burden
  - Reliability & Durability Tested & Improved

- **Vitamix’s Production Concerns**
  - Critical Small Hole Features
  - Production Part Costs

Legacy 6-part design → New single-part design