How do you manufacture parts TOMORROW?
How do you manufacture parts today?

- Investment Casting
- RTV
- CNC
- Welding
- Forming
- Composite
- Lay-up
- Injection Molding
- Machining
- Forging
- Selective Laser Sintering (SLS)
- Rotational Molding
- Extruding
What is Rapid Manufacturing?

• Method for creating end-use products directly on a solid imaging system, such as Selective Laser Sintering (SLS)

• How does SLS work?

3-D CAD data

Raw material

End-use plastic parts
Rapid Manufacturing Benefits

**Tool-Less**
- Eliminate tooling time and cost
- Manufacture directly from 3D-CAD
- No large, up-front tooling expense

**Design for function**
- No limitation on design complexity
- Part count reduction
- Optimized part performance

**Flexible**
- Customized, short production runs
- Modify designs on the fly
Tool-Less Lowers Part Cost

Break Even Point

89 parts

$606

$68

452 parts

$61

906 parts
Part assembly **designed for manufacture** using vacuum-formed plastic parts

Part count  = 16 (plus glue)

Part **designed for function** and built using the SLS process

Part count  = 1
Complex Shapes

- Due to additive nature of SLS, there is no extra cost to create complex designs or contoured shapes
Low Cost and Short Lead Times

- Send digital data (3D-CAD files) to 3D Proparts for manufacture
  - Access to equipment **without purchasing system**
  - Many parts built at the same time lowering part unit cost
  - Short lead times (2 - 4 days)
  - Design assistance (“design for function”)
  - AS9100 certified
Part Size

- Multiple pieces can be joined to create very large parts
- Multiple small parts can be built at same time
- Max one-piece build size
  - 550 x 550 x 750 mm
  - 22 x 22 x 30 in
**Rapid Manufacturing Benefits**

<table>
<thead>
<tr>
<th>BENEFITS</th>
<th>SAVINGS*</th>
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<tbody>
<tr>
<td>Reduced part cost</td>
<td>50% - 80%</td>
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<tr>
<td>Reduced manufacturing time</td>
<td>60% - 90%</td>
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<tr>
<td>Reduced part weight</td>
<td>10% - 50%</td>
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<tr>
<td>Reduced tooling time &amp; expense</td>
<td>90% - 100%</td>
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</tbody>
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*Data derived from UCAV avionic cooling components study*
Where and How?

Where are SLS parts currently used?
- Missiles, pods, and drones
- UAV
- Commercial and Military helicopters
- Fighter aircraft
- Commercial jets, including Boeing 787

Written specifications created for...
- Materials
- SLS process specifications
Aerospace Applications

- Environmental control ducts
- Instrumentation ducts
- Drill jigs and assembly fixtures
- Stowage boxes
- Engineering mock-ups for dynamic evaluations

- Clips
- Bulkhead grommets
- Brackets
- Connectors
- Aerodynamic modeling
- Wiring harness templates
- Electronic enclosures
“One SLS system producing one batch a week for next 6 years”

If there are electronics, power supplies, radars, lasers, cameras, then there is HEAT (which may require cooling)
Pod Air Distribution Ducts

- Reduced part count
- Simplified assembly
- Time and cost savings (as a result of replacing aluminium castings)
- “Just-in-time,” on-demand manufacturing
Optimize Air Handling Ducts
Retainer Bracket

- 200 parts produced in one single SLS build
  - Note: Parts arranged to maximize space usage, keeping costs low
- Delivered to customer in 4 days
- **End use:** space station
Aircraft Defroster Control

Original Design
- Frequent breakage
- Difficult to install
- 9 subcomponents
- Straight hose connection, creating a clearance problem
SLS Manufactured Part

- Increased durability
- One piece design
- Optimized inlet angle to resolve clearance around radios
- Integral hose clamp
- Iterative design with NO TOOLING
DuraForm® PA far passed FAR 23.853(a) testing -- average burn rate <4” [10cm]
Duraform EX far passed FAR 27.853(b) Amend 17FAR 27.855(a)(1)
Duraform FR 100 FAR 25.853 Part I(b)(4),12 Sec. Vertical ABD 0031/AITM 2.0002BBSS 7230 F2
Helicopter Defog Ducts

- 32+ DuraForm® EX parts per helicopter
- More economical than blow molding
- No tooling costs
- Build parts as needed
UAV Engine Cowlings

- Engine cowlings were designed and manufactured in less than one week
- Traditional methods would have taken 4-6 weeks to manufacture
• Dust from manual drilling operation is channeled along tool and extracted via pipe with incorporated attaching feature.
Hydroforming Functional Parts

What is Hydroforming

In sheet hydroforming there is a bladder that contains the liquid, no liquid contacts the sheet. A work piece is placed on a draw ring (blank holder) over a male punch then a hydraulic chamber surrounds the work piece and a relatively low initial pressure seats the work piece against the punch. The punch then is raised into the hydraulic chamber and pressure is increased to as high as 15000 psi which forms the part around the punch. Then the pressure is released and punch retracted and hydraulic chamber lifted and the process is complete.
Hydroforming Application

Applications with Hydroforming

- Short run Metal parts
- The pattern comes from Additive process so it is fast turn around
- Custom one off or low volume
- Metal parts with Deep draw geometries
Indirect Rapid Manufacturing – Rapid patterns for conventional casting and forming
Thank You
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