NU - CAST, INC

A Leader In Aluminum Investment Castings
THE INVESTMENT CASTING TEAM

PROVIDING FOR “REAL SOLUTIONS”
THROUGH EXPERIENCE, UNDERSTANDING, QUALITY, FLEXIBILITY & INOVATION

NU-CAST, INC. (NCI):
Londonderry, N.H. 603-432-1600

ALUMINUM INVESTMENT CASTINGS

PROTO ENGINEERING:
Lowell, Ma. 978-446-0570

ENGINEERING, DESIGN & RAPID PROTOTYPING
NU - CAST, INC

The Ultra-light 3D Cast Truss Beam Structure

The STRENGTH AND weightlessness Every Satellite Needs in Orbit.

NU CAST

IN SPACE, NU-CAST HAS AN EXCELLENT REPUTATION

In the Space, Nu-Cast has been working on a variety of projects. The company has developed a range of structural components for satellites, ensuring their strength and weightlessness. The Ultra-light 3D Cast Truss Beam Structure is one of their key products, designed to meet the needs of every satellite in orbit.

The Strength and weightlessness

Every Satellite Needs in Orbit.

Nu-Cast, Inc.
29 Cambridge Road
Lancaster, NH 03534
Toll-Free: (800) 432-1699
Fax: (603) 432-5724
Email: sales@nucast.com
Web: http://www.nucast.com
NU - CAST, INC

SOLUTIONS FOR
SLA & Other Rapid Prototyping Techniques in
Aluminum & Other Advanced Alloys
ADVANCED INVESTMENT CASTING TECHNOLOGIES

Nu-Cast Inc. uses the latest technologies to
- Cast high strength materials
- Furnish prototypes rapidly
- More than just a Foundry
- Solutions to your Prototype Problems

Nu-Cast Inc. has refined the best methods available to rapidly produce prototypes and investment castings. The methodology combined with an internal dedication to be the best, simply means that you get the best in the time span you require.

In addition to SLA, and LOM patterns other prototype processes are available such as:
- DLM employing selective laser sintering, wax, and polycarbonates
- CNC generated wood patterns and F.T.V. molds for quantities up to 50 pieces.

Turn to Nu-Cast
The Prototype Specialist
NU - CAST, INC

**Engineering Prototypes**

Rapid prototyping enhances the product design and drastically improves your delivery cycle. Multiple technologies allow Nu-Cast Inc. to select the appropriate technology for each application. The maximum cost benefit is obtained when applied in concert with supporting technologies and with a discipline to speed.

**Full CAD Service**

Nu-Cast Inc. can create solid models/SI files from 3D geometry using the following CAD tools:

- Pro E + CATIA + AutoCAD
- CADKEY & others

**Cycle Times for Stereolithography Models & Patterns**

- Engineering Drawings & Development: 14 Days
- Modeling Models & Parts: 3.5 Days
- Investment Casting Patterns: 3.5 Days
- Metal Castings: 7-10 Days
- Rapid Prototype Patterns (RTP): 7-10 Days

**Typical Quanities:**

- 1-2 Parts

**Rapid Prototyping using the following methods**

- **Stereolithography (SLA)**
  produces models from space using a UV laser, directly from CAT data file. Quickcast™ OD systems.

- **Selective Laser Sintering (SLS)**
  from powder into functional patterns and molds, directly from CAT data file.

- **Laminated Object Manufacturing (LOM)**
  using the "fast paper" process. SOM objects serve as expandable patterns.

- **Computer Generated Wood**
  large pattern for walls beyond other rapid prototyping capabilities.

- **Fused Deposition Modeling (FDM)**

**TABLE OF CONTENTS**

- Rapid Prototyping Methods: 1
- Engineering Services: 2
- NCI Teams with NASA: 3
- NCI Teams with Boeing: 4
- Concurrent Manufacturing: 5
- Tolerances & Alloys: 6

**Investment Castings**

**Rapid Prototype Investment Casting**

An alternative source for large complex shapes produced from a stainless steel and new advanced alloys and stainless steel.

- No size limitation
- Wall thickness 0.04 in. down to 0.005 in.
- Investment casting within 7 days to 10 days

**CHECK US**

- West Coast: Aliso, CA: 92656
- East Coast: Raleigh, NC 27605
- Midwest: Chicago, IL: 60607
- South: Atlanta, GA: 30361

**Teamwork**

- Rapid Prototype Patterns + Nu-Cast's R-PIC
- RESULTS IN
- Cast Metal Prototypes in 7-10 Days

**Aluminum 354 A356, A357, 201 C355**

- Beryllium Aluminum Beal 363 & Beal 191
Nu-Cast Inc. now offers Concurrent Manufacturing, much more than concurrent engineering.

Any foundry can make castings from drawings. It takes a very special one to manufacture castings without a complete set of drawings or a CAD file.

It is not the recommended way, but many times it is the only way to meet your delivery requirements.

Nu-Cast Inc. is very experienced in working closely with your engineers and our technicians on a stepped (as information becomes available) manufacturing approach. With our engineering to assist you in development, our personnel have considerable value analysis experience and can be a major asset in meeting your production needs. Our in house tooling, x-ray, penetrant welding and heat treating facilities, enables Nu-Cast Inc. to do it all and do it fast.

By the utilization of rapid prototyping you are provided with the shortest product development cycle possible.
**NU - CAST, INC**

**LINEAR TOLERANCES**
The following tolerances lists the tolerances recommended by the Investment Casting Institute. With state-of-the-art technology, we are able to exceed this list as a guide for larger configurations. Nu-Cast is equipped to handle the demands of today's industry. Your specific configuration is an important criteria in determining dimensional variations from part to part. We will be pleased to consult with you on any tolerances or dimensions you may need that are not listed.

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Normal</th>
<th>Premium</th>
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</thead>
<tbody>
<tr>
<td>up to 1/8&quot;</td>
<td>±.003&quot;</td>
<td>±.005&quot;</td>
</tr>
<tr>
<td>1/8&quot; to 1&quot;</td>
<td>±.010&quot;</td>
<td>±.015&quot;</td>
</tr>
<tr>
<td>1&quot; to 2&quot;</td>
<td>±.015&quot;</td>
<td>±.025&quot;</td>
</tr>
<tr>
<td>2&quot; to 3&quot;</td>
<td>±.015&quot;</td>
<td>±.025&quot;</td>
</tr>
<tr>
<td>3&quot; to 4&quot;</td>
<td>±.020&quot;</td>
<td>±.030&quot;</td>
</tr>
<tr>
<td>4&quot; to 5&quot;</td>
<td>±.025&quot;</td>
<td>±.040&quot;</td>
</tr>
<tr>
<td>5&quot; to 6&quot;</td>
<td>±.030&quot;</td>
<td>±.045&quot;</td>
</tr>
</tbody>
</table>

**Angular and Linear Tolerances at Nu-Cast**
1/4" to 30" ±.020" ±.030"
30" to 40" ±.030" ±.040"
40" to 50" ±.035" ±.045"

<table>
<thead>
<tr>
<th>Section Thickness</th>
<th>Normal</th>
<th>Variation</th>
<th>Premium</th>
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<td>±.010&quot;</td>
<td>±.020&quot;</td>
<td></td>
</tr>
<tr>
<td>1&quot; to 2&quot;</td>
<td>±.015&quot;</td>
<td>±.030&quot;</td>
<td></td>
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<td>±.015&quot;</td>
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<tr>
<td>3&quot; to 4&quot;</td>
<td>±.015&quot;</td>
<td>±.030&quot;</td>
<td></td>
</tr>
<tr>
<td>4&quot; to 5&quot;</td>
<td>±.015&quot;</td>
<td>±.030&quot;</td>
<td></td>
</tr>
<tr>
<td>5&quot; to 6&quot;</td>
<td>±.015&quot;</td>
<td>±.030&quot;</td>
<td></td>
</tr>
<tr>
<td>6&quot; to 8&quot;</td>
<td>±.015&quot;</td>
<td>±.030&quot;</td>
<td></td>
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<tr>
<td>8&quot; to 9&quot;</td>
<td>±.015&quot;</td>
<td>±.030&quot;</td>
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</tr>
<tr>
<td>9&quot; to 10&quot;</td>
<td>±.015&quot;</td>
<td>±.030&quot;</td>
<td></td>
</tr>
</tbody>
</table>

**ALUMINUM-BASE ALLOYS**

<table>
<thead>
<tr>
<th>Alloy Designation</th>
<th>Tensile (ksi)</th>
<th>Yield (ksi)</th>
<th>Ductility (%)</th>
<th>Comments</th>
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<tr>
<td>6061</td>
<td>60-69</td>
<td>44-56</td>
<td>12</td>
<td>(*)</td>
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<tr>
<td>7075</td>
<td>85-90</td>
<td>69-80</td>
<td>12</td>
<td>(*)</td>
</tr>
</tbody>
</table>

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**Our goal is solving your problems whether it be cost, delivery, size or quality.**

For Requirements of Boeing Material Contact Stumer at 1-978-369-5410
Fax 1-978-369-4045
PROTO ENGINEERING

EXPERIENCE/BACKGROUND:

• 36 years in the design, development and management of ground based, airborne and spaceborne optical reconnaissance systems @ ITEK/LITTON.
• 15 years full time and 18 years part time (consulting, design and rapid prototyping) in the investment casting field @ UNI-CAST/NU-CAST.

MAJOR SYSTEMS/PROGRAMS:

• Corona (secret satellite) declassified 1995.
• Classified reconnaissance systems (airborne/spaceborne).
• MOL (Manned Orbiting Lab).
• CIS (Compensating Imaging System) Maui
• Manager of major A/C modification (G111) and systems integration for recce platform including large optical windows and requiring FAA certification/STC’s.

NASA RELATED PROGRAMS:

• Large Space Telescope (Hubble) proposal/study.
• Apollo Program (pan camera for moon).
• Viking Program (Mars Lander camera).
• 30 meter space based laser transmitter (proposal/study).
• Principal Investigator, SBIR Phase 1 & 11 (High Efficiency Monolithic Lightweight Cast Structure).
PROTO ENGINEERING

SERVICES:

ON SITE (CUSTOMER) OR @ PROTO ENGINEERING:

PROVIDE SEMINARS ON THE INVESTMENT CASTING PROCESS AND INVESTMENT CASTING DESIGN (ALUMINUM):

INVESTMENT CASTING DESIGN & ENGINEERING:

• Review systems/components on the basis of function, design, producibility and cost. Discuss casting issues with proposed designs. Provide specific recommendations, alternate design approaches and supporting rationale.

• Systems/component design specializing in airborne & spaceborne applications.
  • Optical systems, components and their mounting.
  • Structural systems and mechanical components.
  • Electronic enclosures.

• Investment casting design.
  • Provide knowledge (basic principles) of the investment casting process and how to realize the maximum benefits of this versatile process based on current technology.
  • Design to cost. Recommend options and provide direction for an efficient cost effective approach.
INVESTMENT CASTING DESIGN & ENGINEERING (CONT’D):

- View problems/issues through the eyes of the customer as well as the foundry, concentrating on part functional requirements for practical solutions. Note; the many years of airborne and aerospace design experience along with the association and actual foundry experience by Proto Engineering, provides for this unique opportunity.

- Provide for realistic tolerancing, dimensional set-up (datum’s/tooling points) and proper transitioning to machining (kinematic type restraints, tooling lugs, etc.).

- Determine those areas/features that should be cast and those that should be machined due to tolerancing or configuration limitations.

- Recommend design techniques that minimize distortion when machined and those processes recommended for long term casting stabilization (critical optical configurations).

- Provide casting design, supporting analysis (FEA/NASTRAN), detail drawings (casting & machining) and solid model (CAD) or variations as required. See the following for typical approach:

  - Discuss/establish design requirements, goals and gather the necessary interface/environmental data via “SCD” or appropriate agreed upon format.

  - Provide preliminary design/layout of proposed approach for customer evaluation and subsequent update and approval. Note; FEA/NASTRAN analysis would be provided at this time if required by customer.

  - Provide detail casting and machining drawings (2D) on customer format per customer specifications and solid model (3D) as required of approved design.
INVESTMENT CASTING DESIGN & ENGINEERING (CONT’D):

• Provide design/detail drawing (2D) and solid model (3D) conversion as required for the following:
  • Dip brazing to casting.
  • Sheet metal to casting.
  • Weldment to casting.
  • Machined part “hog out” to casting.
  • Multi-piece assemblies (sheet metal or machined) to casting.
• Provide engineering drawings per Y14.5M - 1982 or Y14.5M - 1994.
• Assist in material and specification selection:
  • Recommend material specification, classification and method for determining mechanical properties, x-ray of designated areas (when required) and general processing notes based on system/component requirements.
  • Discuss/define advantages/disadvantages.
• Provide the following:
  • Design/detail (2D & 3D) via CADKEY and or PRO E.
  • Systems/part analysis (FEA) via NASTRAN).
RAPID PROTOTYPING (WOOD PROCESS):

• Rapid prototyping process for investment castings unique to Proto Engineering and Nu-Cast Inc Pattern fabrication is via A/C plywood (computer generated or machined assembled parts) as compared with the use of computer generated resins (SLA). This process has been used for over 35 years and currently provides additional flexibility in the use of investment castings for limited production or development runs.

• Advantages over the SLA type process:
  • Design changes can be implemented at any time during pattern generation and even into the shell process in extreme situations. This process in general allows for changes after pattern review.
  • Pattern/part size limited to foundry facility only (currently 80 inches in length @ Nu-Cast Inc).
  • Solid model (CAD) not required (2D acceptable).
  • Fillet radii and outside radii not required in CAD file.
  • Minimal wall thickness .02/.03 available (requires engineering or foundry review).
  • No pattern shrinkage to contend with allowing for greater pattern tolerance control,
The National Aeronautics and Space Administration's Spartan Project proudly presents this award to

PROTO ENGINEERING

In recognition and appreciation of your participation in the Spartan 207/Inflatable Antenna Experiment (IAE), which was deployed by the crew of the Space Shuttle Endeavour, STS-77, on May 20th 1996.

Mark Steiner
Spartan 207/IAE Mission Manager
NU - CAST, INC

Wax Injection
(Large Injection Tool Depicting Cores With Red Wax Pattern On Left)
Part Production Cycle - Investment Castings

### NU - CAST, INC

**NORMAL CYCLE TIME (LOT QTY.) WORKING DAYS**

| FUNCTION                      | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|-------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| (Initiate Prod. Cont. W.O.)   |   |   |   |   |   | 2 |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Wax Injection                 |   |   |   |   |   | 2 |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Wax Assembly                  |   |   |   |   |   | 4 |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Shell (Investment)            |   |   |   |   |   | 2 |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Foundry                       |   |   |   |   |   | 1.5 |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Washout (Gate Cut-Off Removal) |   |   |   |   |   | 1 | 1.5 | 1 | 1 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Rough Grind                   |   |   |   |   |   | 1 | 1 | 1 | 1 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Fine Grind                    |   |   |   |   |   | 1 | 1 | 1 | 1 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Heat Treat (T6)               |   |   |   |   |   | 1 | 1 | 1 | 1 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Straightening                 |   |   |   |   |   | 1 | 1 | 1 | 1 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Heat Treat (T6)               |   |   |   |   |   | 1 | 1 | 1 | 1 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Sand Blast                    |   |   |   |   |   | 1 | 1 | 1 | 1 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Zygro (Production)            |   |   |   |   |   | 1 | 1 | 1 | 1 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Inspection*                   |   |   |   |   |   | 1 | 1 | 1 | 1 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

**NOTE:** This chart denotes the normal cycle time for an average production run (lot qty.). Exceptions and/or additions to basic chart would be as follows:
1. New Part (Sample) - Add 5 days
2. Layout (First Article) - Add 5 days
3. Large Complicated Part - Add 4 days
4. Outside Processing
   A. Finish: (Plating, Coating, Sealing, Etc.) - Add 4 days
   B. Machining - T.B.D.
   C. Assembly - T.B.D.

*Includes: A. Penetrant (Zyglo) if req’d.
   B. X-Ray (AQL), if req’d.
   C. Physical Inspection (AQL).
NU - CAST, INC

Electronic Housing (Investment Casting)

Electronic Housing (Investment Casting)
NU - CAST, INC

Optical Housing (Investment Casting)
NU - CAST, INC

NEXT-GENERATION AIRBORNE/SHIPBOARD IFF TRANSPONDER

BAE SYSTEMS' Next-Generation Common Avionics Transponder is produced under contract for the F/A-18 MIDS Compatibility IFF Transponder Upgrade Program. Competitively selected over advanced versions of the AN/APX-100, BAE SYSTEMS' new IFF transponder incorporates all the advanced features required in today's global military/civil air traffic control environment. The transponder's open system architecture design and high-density FPGA technology ensure ongoing versatility and future utility through software upgrade only, without the risk and cost associated with hardware modifications. The Next-Generation Common Transponder is configured for replacement of all AN/APX-100, AN/APX-101, AN/APX-108, AN/APX-72, AN/APX-64 and AN/UPX-99 transponder installations.

AN/APX-117(V) AN/APX-118(V)
COMMON TRANSPONDERS (CXP)

BAE SYSTEMS' Common Transponder (CXP) was selected by the U.S. Navy/Army as their future transponder. The AN/APX-117(V) and AN/APX-118(V) incorporate all the advanced features required in today's global military/civil air traffic control environments. The transponder's open system architecture design and high-density FPGA technology ensure ongoing versatility and future utility through software upgrade only, without the risk and cost associated with hardware modifications. The AN/APX-117(V) and AN/APX-118(V) are configured for replacement of all AN/APX-100, AN/APX-101, AN/APX-108, AN/APX-64, AN/APX-72 and AN/UPX-99 transponders.

Electronic Housings (Investment Castings)
NU - CAST, INC

Optical Housing (Investment Casting)

Electronic Chassis (Investment Casting)
NU - CAST, INC

Missile Electronic Housing, Cover & Chassis
(Investment Casting)
NU - CAST, INC

Electronic Housings (SLA”S)

Electronic Housings (Investment Castings)
NU - CAST, INC

Housings (SLA’S)

Gimbal & Housing (SLA’S)
NU - CAST, INC

Housing & Covers, ATIRCM (SLA'S)

Housing, Support, ATIRCM (SLA)
NU - CAST, INC

Housing
(Investment Casting & SLA)

Housing
(Investment Casting & SLA)
SLA PATTERNS
TOP: THAAD Optical Sensor Housing
BOTTOM: Pump Housing

Thrust Deflector Housing
LEFT: Deflector, Investment Casting
RIGHT: Deflector, SLA Pattern
NU - CAST, INC

Electronic Housings (Investment Castings)

FLIR Optical Housings, Inv. Casting
(Casting Design/Engineering By Proto Engineering)

TOW Optical Housing, Inv. Casting
(Casting Design/Engineering/Conversion By Proto Engineering)
Rail, A/C Missile Launcher Housing (Investment Casting)

Rail, A/C Missile Launcher Housing (Investment Casting)
NU - CAST, INC

Optical Bench, “3D” Truss, Offner Relay Test, NASA/GSFC (SBIR II)
Wood Prototype (Top), Investment Casting (Bottom)
NU - CAST, INC

J. Bowkett With SMEX • Lite ,NASA/GSFC
(Wood Prototype, Other Samples In Background)
NU - CAST, INC

DB - 110 Recce Roll Frame & Optical Bench
(Wood Prototypes)
DB - 110 Roll Frame (Goodrich Recce System)
(Investment Casting Designed By Proto Engineering)
NU - CAST, INC

DB - 110 Recce System, Goodrich Roll Frame & Optical Bench
(Wood Prototypes)
NU - CAST, INC

DB - 110 Recce System
(Camera Assembly On Fixture)

DB - 110 Recce System
(Camera Assembly On Fixture)
NU - CAST, INC

Boeing 767 A/C Main Landing Gear Door Uplock Support (Cast Conversion)
NOTE: Conversion Eliminated 27 Part Numbers

Boeing 767-40ER A/C Cockpit (Cast Conversion)
NOTE: Conversion Reduced 296 Part Numbers To 53 (With 11 Casting Assemblies) & Cost By 50 %

Boeing 777 A/C Outboard Overhead Stow Ben End Frame (Cast Conversion)