

Harmony Castings, LLC

TPi Arcade, INC

V-PROCESS Aluminum Castings



Remolding an Industry

HARMONY
Castings LLC

TPi ARCADE
INC

Using the V-PROCESS for Production and Prototype Casting Requirements

- What is the V-PROCESS and how it works
- V-PROCESS produces castings with a smooth surface, and excellent detail. They may be machined, painted and used as a production part



What is the V-PROCESS

One of the newest casting processes; the “**V-PROCESS**” in which unbonded sand is held in place in the mold by a vacuum. In this process the pattern is covered by a tightly conforming thin sheet of plastic which is applied with vacuum after being heated. A flask is placed over the plastic coated pattern, and is filled with free-flowing sand. Another sheet of plastic is placed over the top of the sand in the flask and the flask is evacuated. The vacuum "hardens" the sand so the pattern can be withdrawn. The other half of the mold is made the same way. After cores are put in place, the mold is closed and poured while still under vacuum. When the metal has solidified, the vacuum is turned off and the sand runs out freely, releasing the casting.



In Choosing a Process You Must Consider Casting Requirements

- 1. Does the casting have structural requirements?
Pressure or Vacuum**
- 2. Is dimensional accuracy your prime importance?
Dimensional stability**
- 3. What alloy do you require?**
- 4. What test requirements or quality standards do you need?**

All this helps you decide where to go.

Advantages of V-Process

- 1. No Draft**
- 2. Accurate Tolerances**
- 3. Unlimited Pattern Life**
- 4. Smooth Surface Finish 125 RMS**
- 5. Thin Wall Thickness**
- 6. Economic Prototype and Production Quantities**

V-PROCESS Prototype Applications

- CAD Model to Castings in 2-4 weeks
- Large or Small Castings Same Lead Time

Prototype Quantities 5 - 500

V-PROCESS Production Applications

The only difference between prototype and production tooling is the additional impressions that may be added to the pattern to fully utilize the entire mold cavity

- Medical Devices
- Computer
- Instrumentation
- Electronic Enclosures

Production Quantities

5,000 - 10,000

What is the V-PROCESS

Metals: Aluminum (A356, 356, 319, 339)
Heat Treat (T5, T51, T6)

Flask Sizes:

15" x 20" x 6"/6"	380 x 380 x 150 / 150mm
36" x 36" x 9"/9"	915 x 915 x 230 / 230mm
36" x 48" x 12"/12"	915 x 1220 x 300 / 300mm
36"x24" x 12"x12"	915x 610 x 300/300 mm

Tolerances: One side of parting line $\pm .010$ " up to 1". Over 1" add $\pm .002$ "/in. Across parting line add $\pm .010$ ".
Additional tolerance required for cored surfaces

Surface Finish: V-Process 125RMS to 150RMS Cored 150RMS to 250RMS

Minimum Draft Requirements: Zero, None Required

Normal Minimum Section Thickness: .125" (2.5mm)

Process	Description	Typical Size Range	Tolerances	Surface Finish	Min. Draft Required	Min. Section Thickness	Typical Order Quantities	Typical Tooling Costs	Nominal Lead Times
V-PROCESS Castings	Extremely fine sand is "vacuum packed" around pattern halves. The pattern is removed and metal poured into cavity. The vacuum is released and the casting removed.	Up to 150 lbs	$\pm .010"$ for the first 1", then add $\pm .002"$ inches/inch. Add $\pm .020"$ across parting line	125-150 RMS	None	.125"	All	\$3,000 to \$14,000	Samples: 2 to 6 weeks Production: 2 to 6 weeks after approval
Sand Castings	Treated sand is molded around a wood or metal pattern. The mold halves are opened and the pattern removed. Metal is poured into the cavity. The mold is broken and the casting removed.	Ounces to tons	$\pm 1/32"$ to 6", then add $\pm .003"$ inches/inch. Add $\pm .020"$ to $.090"$ across parting line	200-550 RMS	1 to 5 degrees	.25"	All	\$800 to \$4,000	Samples: 2 to 6 weeks Production: 2 to 6 weeks after approval
Investment (Lost Wax)	A metal mold makes wax replicas. These are joined and surrounded by an investment material. Wax is melted out and metal is poured into the cavity. The molds are broken and the casting removed.	Ounces to 20 lbs	$\pm .003"$ to $1/4"$ $\pm .004"$ to $1/2"$ $\pm .005"$ to 3", then add $\pm .003"$ inches/inch.	63-125 RMS	None	.060"	Under 1000	\$3,000 to \$20,000	Samples: 8 to 10 weeks Production: 5 to 12 weeks after approval
Permanent Mold	Molten metal is poured into a steel mold. The mold is opened and the casting is ejected.	Ounces to 100 lbs	$\pm .015"$ to 1", then add $\pm .002"$ inches/inch. Add $\pm .010"$ to $.030"$ across parting line	150-300 RMS	2 to 5 degrees	.1875"	500+	\$5,000 to \$25,000	Samples: 8 to 20 weeks Production: 10 to 12 weeks after approval
Plaster Mold	A plaster slurry is poured into the pattern halves. After setting, the mold is removed from pattern, baked, assembled and metal poured into the cavity. The mold is broken and the casting removed.	Ounces to 50 lbs	$\pm .005"$ to 2", then add $\pm .002"$ inches/inch. Add $\pm .010"$ across parting line	63-125 RMS	1/2 to 2 degrees	.070"	Prototypes up to 250 pcs	\$3,000 to \$15,000	Samples: 2 to 10 weeks Production: 4 to 8 weeks after approval
Die Casting	Steel dies, sometimes water cooled, are filled with molten aluminum. The metal solidifies, the die is opened and the casting ejected.	Ounces to 15 lbs	$\pm .002"$ inches/inch. Add $\pm .015"$ across parting line	32-63 RMS	1 to 3 degrees	.030" to .060"	2500+	\$10,000 to \$100,000	Samples: 12 to 22 weeks Production: 8 to 14 weeks after approval

Tolerance Comparison

<u>Casting Method</u>	<u>3 Inches</u>	<u>6 Inches</u>	<u>12 Inches</u>	<u>24 Inches</u>	<u>Parting Line Shift Requires an Additional</u>	<u>As Cast Surface Finish (RMS)</u>
V-Process	±.014	±.020	±.032	±.056	±.020	125-150
Sand Cast	±.030	±.035	±.060	±.125	±.020-.060	250-500
Permanent Mold	±.019	±.025	±.037	±.061	±.010-.025	50-200
Plaster Mold	±.015	±.024	±.042	±.078	±.015	90-125
Die Cast	±.006	±.009	±.015	±.027	±.015	30-60
Investment Cast	±.009	±.015	±.027	±.051	N/A	90-125

NOTE:

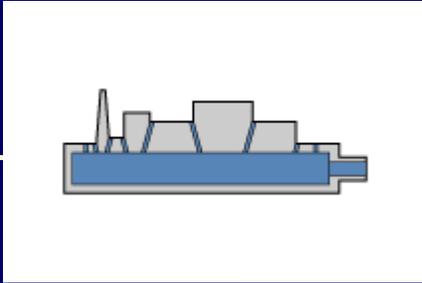
1. FOR EACH PROCESS LISTED, CORED AREAS OR SLIDES, REQUIRE INCREASED TOLERANCES.
2. LISTED TOLERANCES ARE FOR CASTING, PRIOR TO MACHINING.
3. "RMS" FOR CORED AREAS WILL VARY.
4. FLATNESS DEPENDS ON SIZE AND GEOMETRY OF THE PART.

V-PROCESS Demonstration

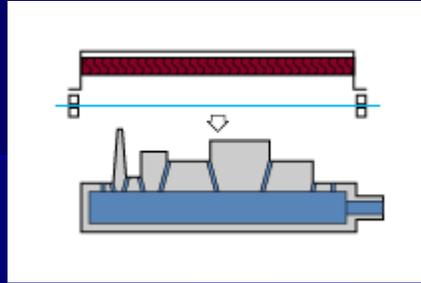


The V-PROCESS Sequence

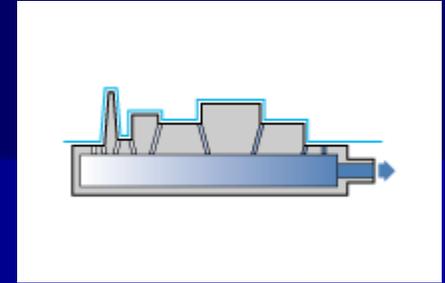
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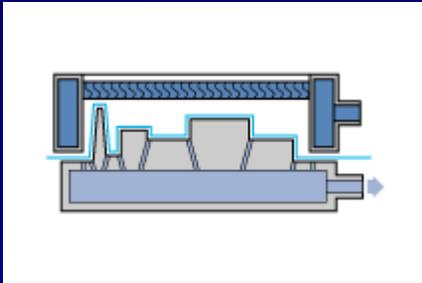
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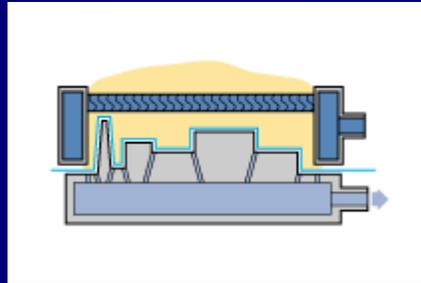
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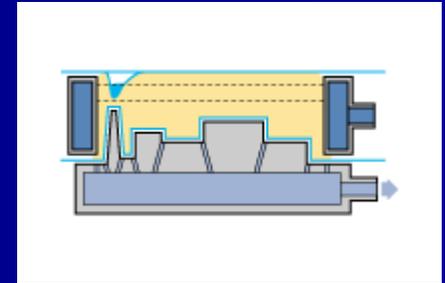
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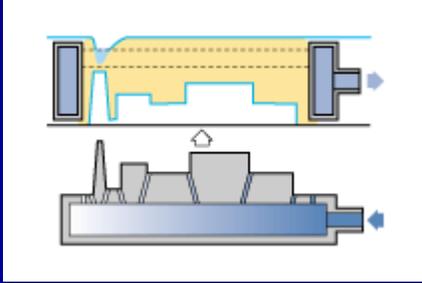
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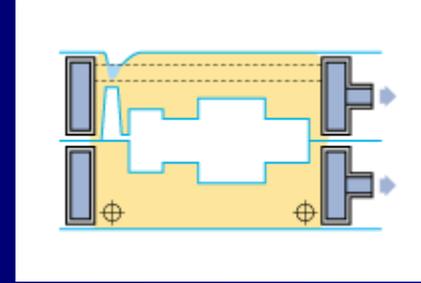
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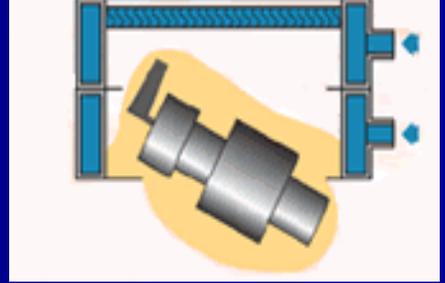
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8.



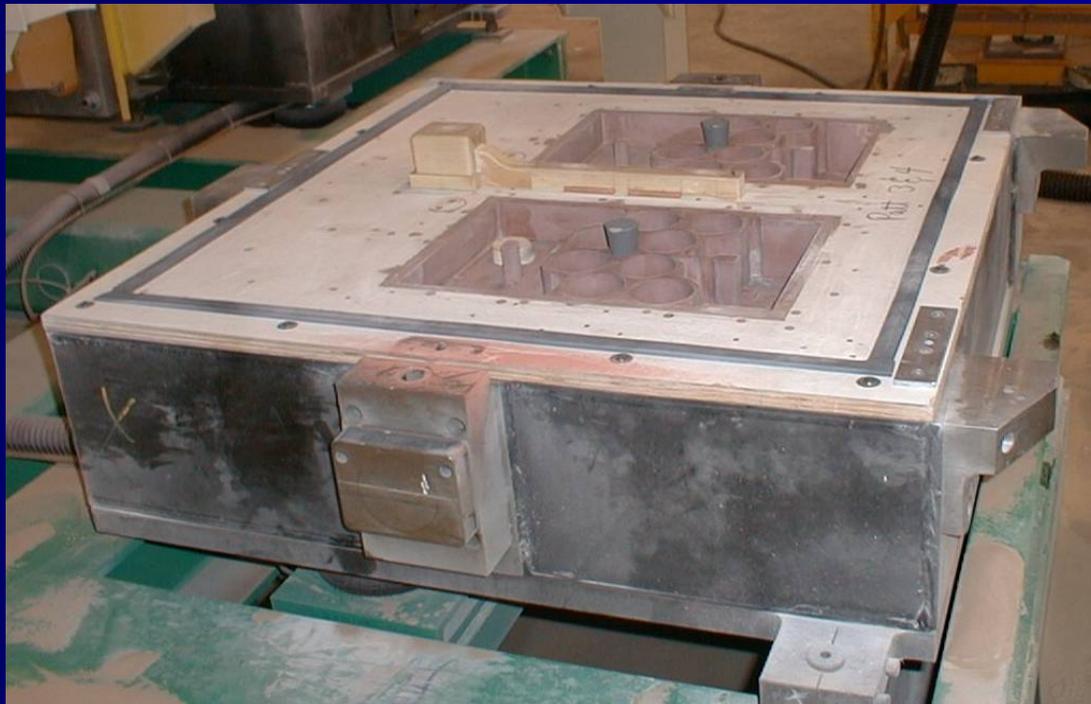
9.



How the V-PROCESS Works

Step #1

- Pattern is placed in a hollow pattern carrier



How the V-PROCESS Works

Step #2

- A thin sheet of plastic film is heated and vacuum fitted to the pattern



How the V-PROCESS Works

Step #3

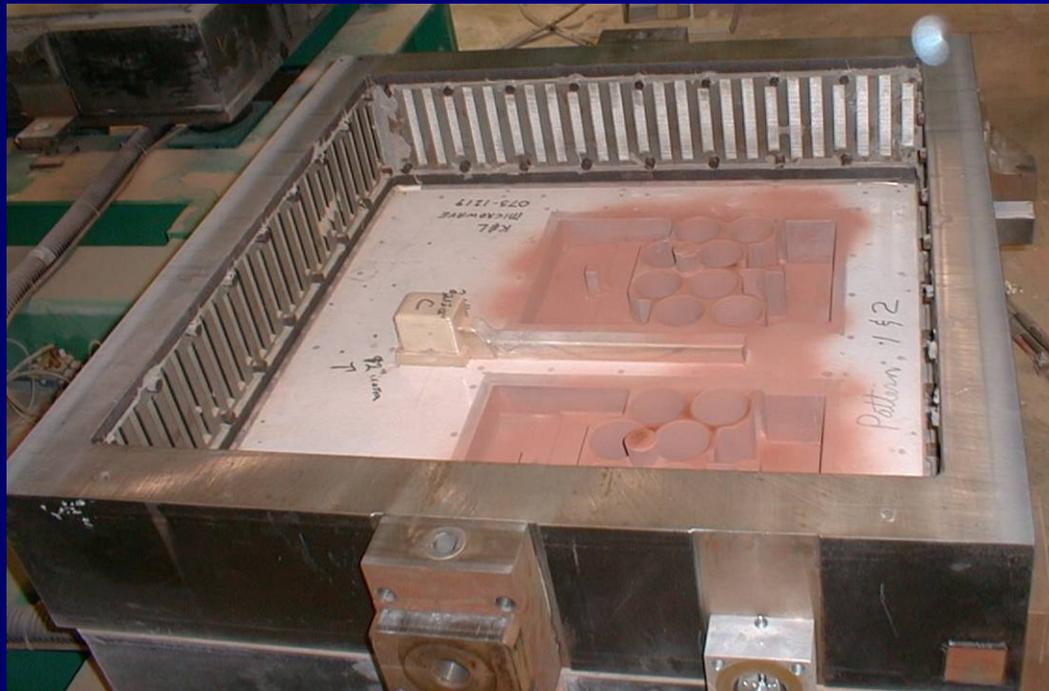
- Pattern is now covered (shrink-wrapped) with a thin sheet of plastic film



How the V-PROCESS Works

Step #4

- Flask is placed around the film-covered pattern



How the V-PROCESS Works

Step #5

- Flask is filled with a fine, dry unbonded sand. A slight vibration compacts the sand to maximum bulk density



How the V-PROCESS Works

Step #6

- A second sheet of plastic film is placed on top of the mold and vacuum is applied to the flask and released from the pattern



How the V-PROCESS Works

Step #7

- The flask is stripped off the pattern and placed on the pouring line



How the V-PROCESS Works

- The other half of the mold is produced in a similar manner (steps 1 thru 7) and aligned to the first half

How the V-PROCESS Works

Step #8

- The cope and drag assembly form a plastic-lined cavity ready to be filled with aluminum



How the V-PROCESS Works

Step #9

- The cope and drag assembly while remaining under vacuum are poured

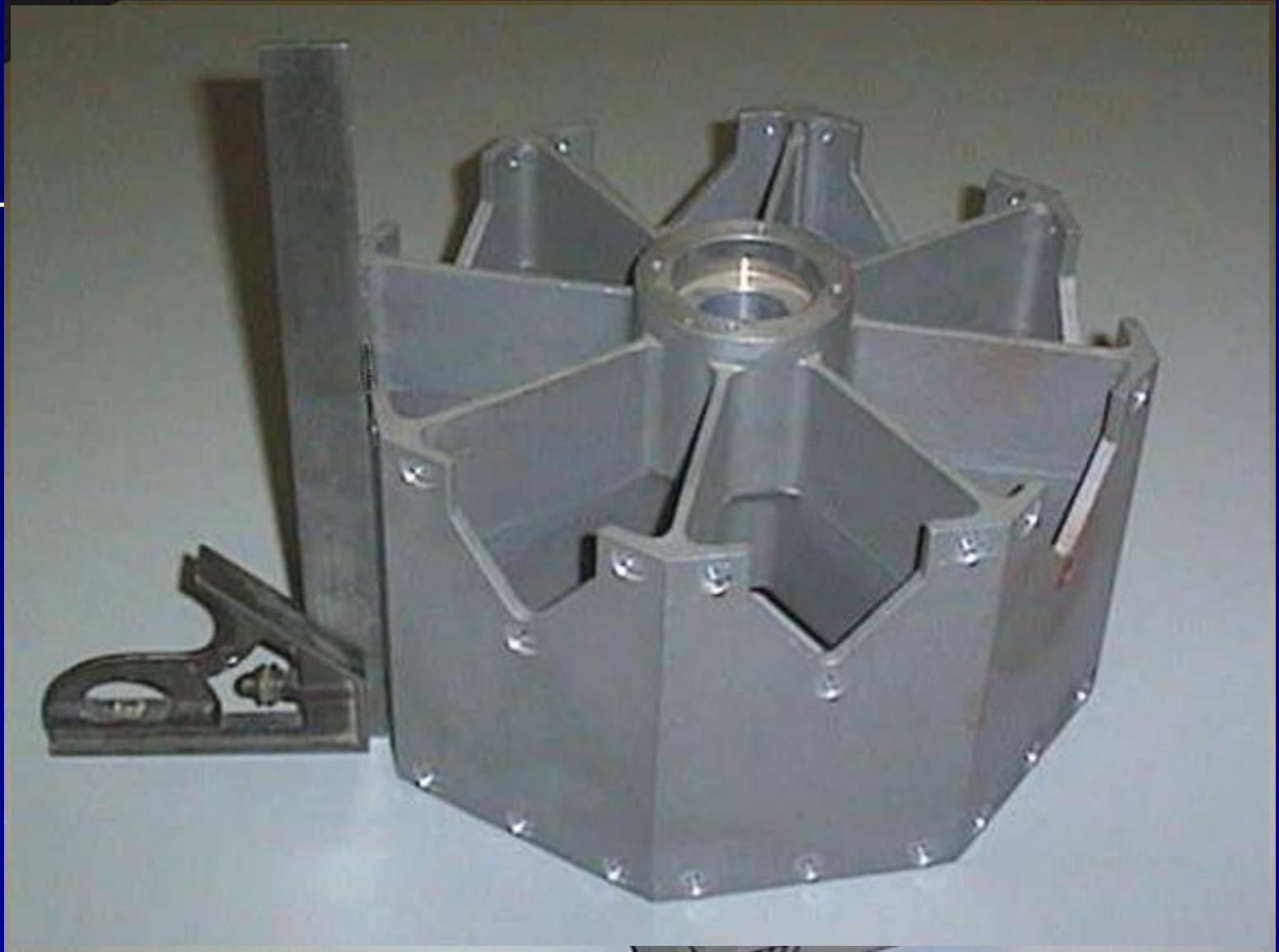


How the V-PROCESS Works

Step #10

- After the metal has solidified the vacuum is released





Tolerance Issues

Flatness

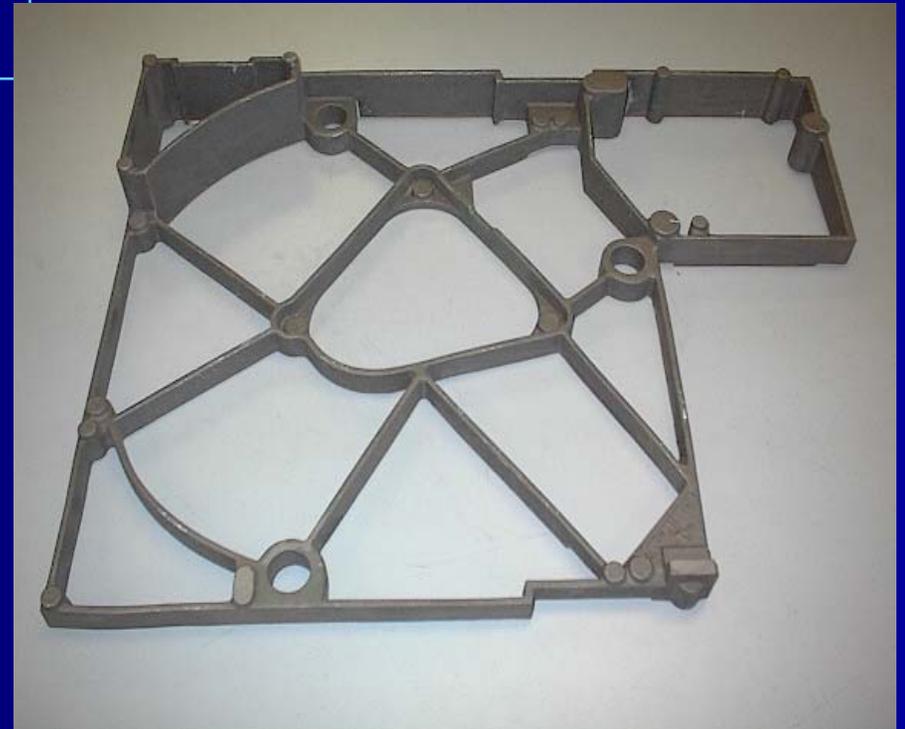
Straightening

Dimensional

Geometry Review

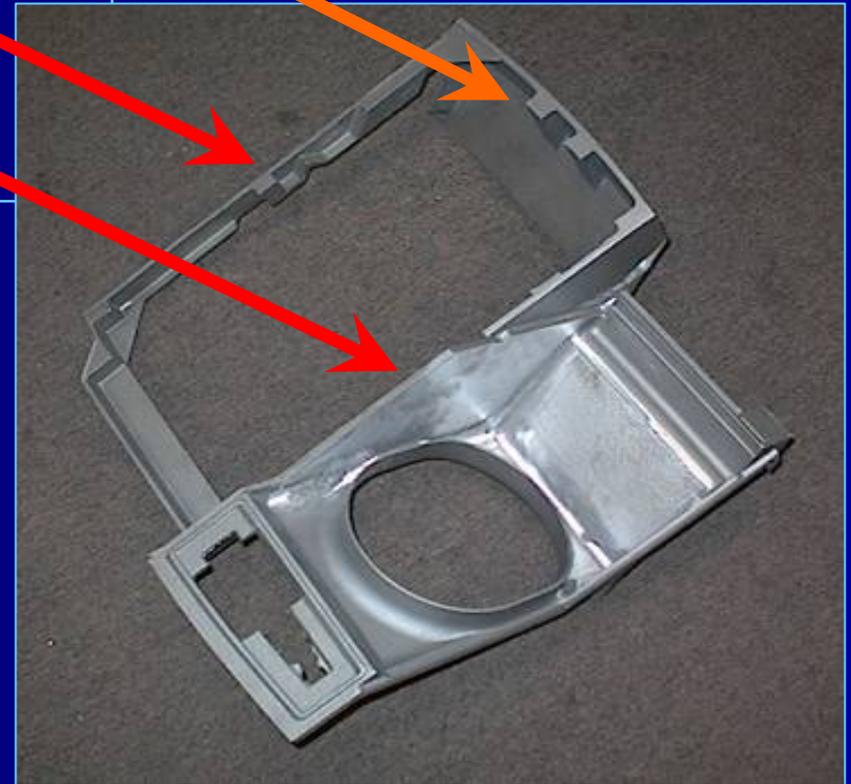
Hard to Feed Areas

Isolated Sections



Considerations

1. Isolated Bosses
2. Lack of Strength
3. Thin Wall Thickness



Wall Thickness

Walls as thin as .090 in exceptional cases.

.125 - .150 and normal

.50 or more are possible.

Part Size

30" x 40" Large size

7" small size

Alloy

A-356 and 319

Quantities

Prototype to production (5,000 - 10,000 per year)

Cost Drivers

Size of parts / number of impressions
Complexity of geometry / molds per shift
Cores, and complexity
Amount of time required for cleaning and grinding.
Weight of casting
Heat treat requirements
Testing, X-rays, Certification, Test bars

Cores and Their Uses

- A core is made from chemically bonded sand
- Accuracy is affected
- Surface finish is affected



V-PROCESS Tooling

Soft tooling quick to build Wood, Plastic, Epoxy

Does not wear out

Revisions are made easily

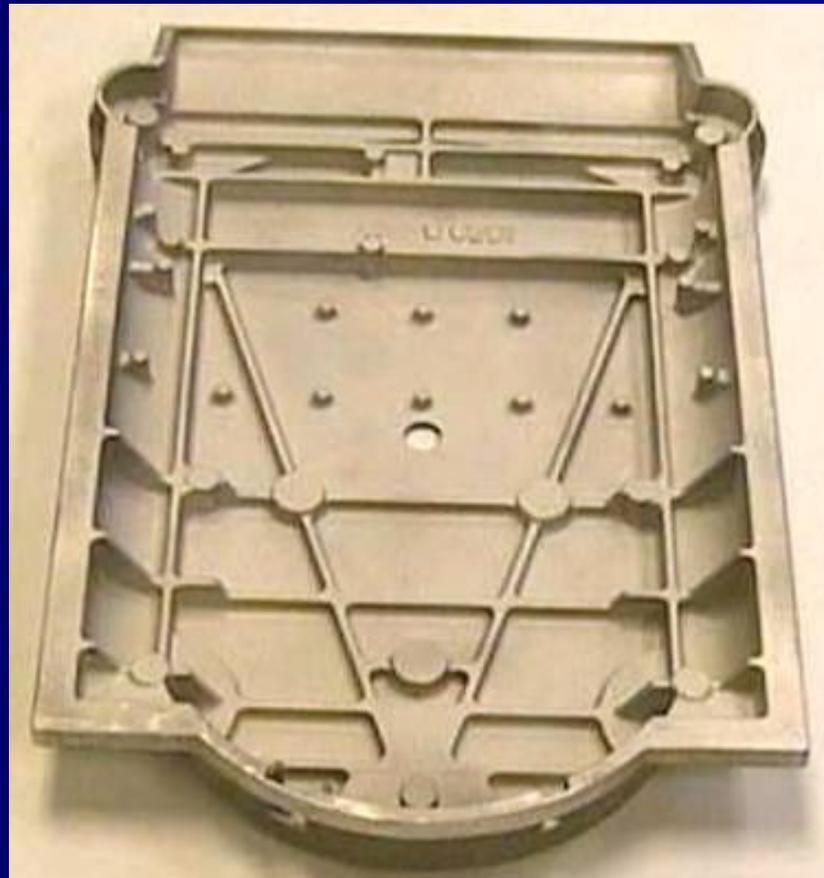
No draft required

Rapid delivery

Epoxy Patterns Created from Machined Molds



Completed Casting Delivered in 1 - 2 Weeks



Examples of V-PROCESS Castings



Harmony Castings, LLC
REMODELING AN INDUSTRY
TPi Arcade, INC