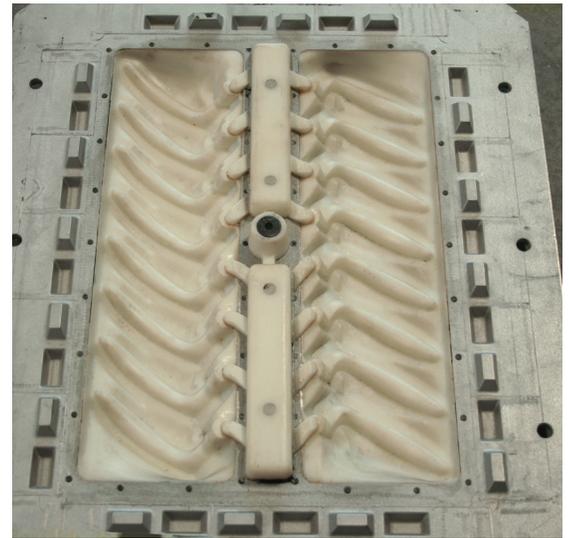




## TECHNICAL APPLICATION GUIDE

# FDM FOR SAND CASTING

Sand casting is a cost-effective, efficient process for small-lot production or high-volume manufacturing when used in conjunction with automated equipment. The sand casting process is relatively simple, however the fabrication of patterns to produce the sand molds can be time consuming and labor intensive. This document addresses two approaches to sand casting: green (wet) sand casting and no-bake (air-dry) sand casting. Many pattern designs used in the sand mold making process are also detailed in this document including matchplate patterns, split patterns, gate and runner systems, core boxes and resin cast patterns.



FDM matchplate insert with interchangeable gate and runner system.

# FDM FOR SAND CASTING

## CONTENTS

- 1. OVERVIEW .....2**
  - 1.1. Application .....2
  - 1.2. FDM is a best fit.....2
  - 1.3. Successful adopter traits.....2
  - 1.4. FDM adoption obstacles .....3
  - 1.5. Benefits .....3
- 2. TRADITIONAL PROCESS OVERVIEW.....3**
  - 2.1. Steps in the traditional sand casting process.....3
  - 2.2. FDM adjustments .....4
- 3. PATTERN DESIGN .....4**
  - 3.1. Matchplate inserts .....4
  - 3.2. Split patterns .....5
  - 3.3. Loose patterns .....5
  - 3.4. Gate and runners .....5
  - 3.5. Core box.....5
  - 3.6. Resin patterns .....5
  - 3.7. Other considerations.....6
- 4. FILE PREPARATION .....6**
  - 4.1. In Insight™ software, open the STL file .....6
  - 4.2. Part interior style .....7
  - 4.3. Visible surface style.....7
  - 4.4. Create toolpaths and support .....7
- 5. MATERIALS .....8**
- 6. PATTERN PREPARATION .....8**
  - 6.1. Remove supports.....8
  - 6.2. Smooth molding surfaces .....8
  - 6.3. Assemble patterns .....9
  - 6.4. Apply face coat (optional).....9
  - 6.5. Apply release agent.....9
- 7. MOLD MAKING AND CASTING.....9**
  - 7.1. Mold making.....9
  - 7.2. Casting .....10
- 8. TOOLS & SUPPLIES .....10**
  - 8.1. Required items .....10
  - 8.2. Optional items .....10
  - 8.3. Sources.....10
- 9. KEY PROCESS CONSIDERATIONS .....10**
  - 9.1. Resolution details.....10
- 10. RECAP - CRITICAL SUCCESS FACTORS.....11**
  - 10.1. Actions .....11
  - 10.2. Optimize patterns.....12
  - 10.3. Eliminate adoption obstacles .....12

## APPLICATION COMPATIBILITY

TECHNOLOGY	IDEA	DESIGN	PRODUCTION
FDM	1	2	4
PolyJet	1	3	4

(0 – N/A, 1 – Low, 5 – High)

## COMPANION AND REFERENCE MATERIALS

<a href="#">Technical application guide</a>	<ul style="list-style-type: none"> <li>• Document</li> </ul>
<a href="#">Application brief</a>	<ul style="list-style-type: none"> <li>• Document</li> </ul>
<a href="#">Video</a>	<ul style="list-style-type: none"> <li>• Commercial</li> <li>• Success story</li> <li>• How It's Used</li> </ul>
<a href="#">Referenced processes</a>	<ul style="list-style-type: none"> <li>• Sparse fill</li> <li>• Metal inserts</li> <li>• Section large parts</li> <li>• Custom groups</li> <li>• Finishing techniques</li> <li>• Optimize seam location</li> <li>• Orienting for smooth part</li> <li>• Part dipping</li> </ul>

# FDM FOR SAND CASTING

## 1. OVERVIEW

### 1.1. APPLICATION:

For sand casting, FDM produces the patterns that form the sand molds.

- Proven to work with:
  - Flaskless methods
  - Flask methods
  - Green (wet) sand process
  - No-bake (dry) sand process

### 1.2. FDM IS A BEST FIT WHEN:

- Casting quantity
  - Low to moderate production volumes (5,000+).
- Pattern size
  - < Build envelope of FDM system.
- Compaction pressure
  - Below 20.7 MPa (3,000 psi) with ABS.
- Castings design
  - Moderate to high design complexity.
- Finishing
  - All surfaces are accessible for smoothing, sealing and/or coating.



Figure 1: Window hardware manufactured with FDM matchplate.

# FDM FOR SAND CASTING

### 1.3. SUCCESSFUL ADOPTER TRAITS (FIRST ITERATION AND LONG-TERM):

- Good casting and mold design
  - FDM assists in refining both but cannot overcome poor designs.
- Test pours followed by pattern, gate or runner modifications
  - Prove part design (shrink rate, fitment).
  - Prove mold design (chills, risers, runners and gates).
- Understanding when FDM is the best alternative
  - Continue to use traditional methods in combination with FDM.
- Thorough pattern preparation
  - Rushing through sanding, filling and coating may lead to sand tearing from mold.

### 1.4. FDM ADOPTION OBSTACLES:

OBSTACLE	SOLUTION*
Overly large patterns	<ul style="list-style-type: none"> <li>• No size limit. However, sectioning and bonding may undermine time and cost advantages.</li> </ul>
Surface finish causing sand tearing.	<ul style="list-style-type: none"> <li>• Use proper finishing methods for smooth parts.</li> <li>• Use the Finishing Touch™ Smoothing Station.</li> <li>• Lightly sand patterns.</li> <li>• Choose orientation to optimize strength and surface finish.</li> <li>• Use fillers to help smooth the pattern.</li> <li>• Use a top coat such as Master Foundry-Kote.</li> <li>• Use a sandable paint primer.</li> </ul>
Pattern deflection and cracking	<ul style="list-style-type: none"> <li>• Orient part for surface finish and compressive strength.</li> <li>• Use proper material for strength requirements.</li> <li>• Use Insight software settings to optimize strength and fill small features.</li> </ul>
Small features may prematurely fail.	<ul style="list-style-type: none"> <li>• Orient parts for strength and surface finish.</li> <li>• Use proper material for strength requirements.</li> <li>• Use Insight software settings to optimize strength and fill small features.</li> </ul>

\* Additional solutions may exist.

# FDM FOR SAND CASTING

## 1.5. BENEFITS:

- Lead time reduction
  - Average lead time savings: 30% to 70%.
- Cost reduction
  - Average cost savings: 60% to 80%.
- Modifications
  - Allows redesigns to part/pattern and gate/runner system.
  - Optional use of interchangeable components.
- Automated pattern production
  - Reduces burden on pattern shop.
  - Keeps pattern production in-house.



Figure 2: Machined aluminum matchplate.

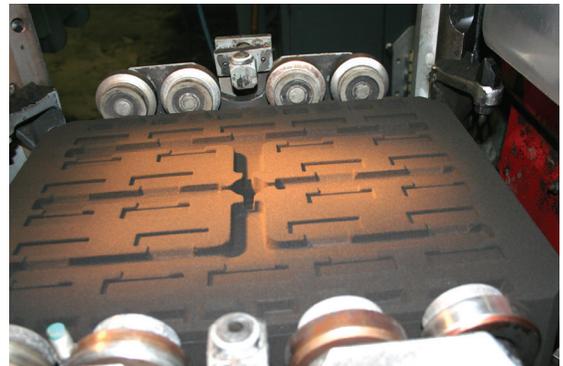


Figure 3: Flaskless, green sand cope.

## 2. TRADITIONAL PROCESS OVERVIEW

### 2.1. THE STEPS IN THE TRADITIONAL SAND CASTING PROCESS ARE:

#### 2.1.1. MAKE PATTERN (FIGURE 2).

- Options include matchplate, split patterns, loose patterns and core boxes.

#### 2.1.2. MAKE SAND MOLD (FIGURE 3).

- Cope side:

# FDM FOR SAND CASTING

- Compact sand against pattern.

- Drag side:

Compact sand against pattern.

### 2.1.3. ASSEMBLE MOLD; COMBINE COPE AND DRAG SIDES.

### 2.1.4. POUR METAL AND COOL (FIGURE 4).

### 2.1.5. REMOVE SAND (FIGURE 5).

### 2.1.6. CUT OFF GATES AND RUNNERS.

### 2.1.7. FINISH TO SPECIFICATION.

## 2.2. FDM ADJUSTMENTS

### 2.2.1. REPLACE MACHINED PATTERNS WITH FDM PATTERNS.

### 2.2.2. NO OTHER DESIGN OR PROCESS ALTERATIONS ARE NECESSARY.



Figure 4: Casting metal into green sand mold.



Figure 5: Vibratory bed for sand removal.

## 3. PATTERN DESIGN

The pattern design for FDM patterns is relatively unchanged from the traditional process. Below are the FDM details specific to each pattern style.

### 3.1. MATCHPLATE INSERTS

The matchplate combines an FDM insert with a pre-fabricated metal blank. The FDM insert provides the sand impression for

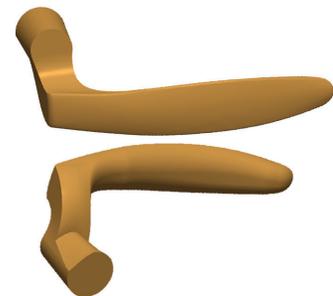


Figure 6: CAD model (front and rear views shown) for window handle.

# FDM FOR SAND CASTING

the part, gates and runners. The aluminum blank, which has pockets to hold the FDM insert, provides a rigid structure that prevents damage. The design configuration for the part, gates and runners is the same as that used when making matchplates conventionally.

### 3.1.1. SPLIT THE PATTERN.

Separate the two halves by an amount equal to the thickness of the matchplate blank (Figures 7 and 8).



Figure 7: Split the CAD model along the parting line and separate the halves by the thickness of the matchplate blank.

### 3.1.2. CREATE MOUNTING FLANGE.

The last step is to extend a flange around the insert that matches the size of the pocket that is machined into the matchplate blank. On the flange, incorporate bolt holes for attachment. Spacing of 25 – 50mm (1- 2 inches) is sufficient.

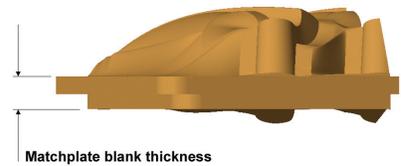


Figure 8: Side view of matchplate pattern showing allowance for matchplate blank.

### 3.1.3. MULTIPLE INSERTS.

For matchplates with two inserts, machine two pockets in the metal

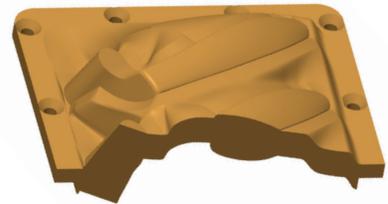


Figure 9: Section view of pattern. Note that runner system is excluded (see 3.3.2).

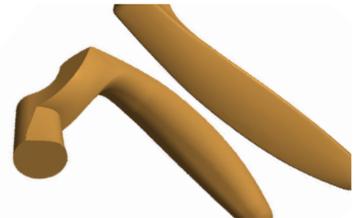


Figure 10: Matchplate insert (cope side) with 8 window handles.

# FDM FOR SAND CASTING

blank. Separate the pockets with a “rib” of during sand compaction (Figure 12).

### 3.2. SPLIT PATTERNS

Split patterns can replace a single, two-sided insert (Figure 13). Follow the instructions above but produce two separate CAD files. Each split pattern will have a flat side that flush mounts to a solid base on a metal or wooden blank.

### 3.3. LOOSE PATTERN

A loose pattern is a copy of the part to be cast that also incorporates shrinkage allowance. Loose patterns are often used to produce prototype castings or for other low quantity applications because they can be created quickly and inexpensively. Loose patterns typically have simple parting lines which facilitate easy mold creation.

### 3.4. GATE AND RUNNER COMPONENTS

If alterations to the mold configurations are likely, extract the gates and runners from the insert and design them as separate components that will also be made with FDM. This approach isolates the redesign and rebuilding process to just the gate or runner



Figure 11: Matchplate insert (drag side).



Figure 12: Matchplate blank incorporates a thick “rib” between inserts for stiffening.

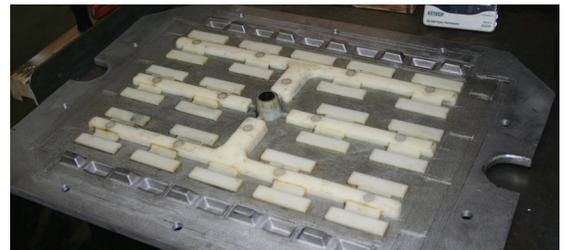


Figure 13: Split pattern matchplate. FDM patterns mount flush to each side of blank.



Figure 14: CAD models of interchangeable runner systems for casting refinement.

# FDM FOR SAND CASTING

which reduces the time and expense when refining the mold design (Figures 14 and 15).

### 3.5. CORE BOX

For features that cannot be incorporated in the cope or drag (e.g., an internal cavity), loose sand cores are placed in the sand casting mold prior to pouring metal. These cores are made by packing sand in the cavity of a core box (Figure 16).

Using the CAD model of the sand cast part, create a CAD model of the void within the part. Next, add core plugs, features that locate the core in the sand casting mold. Then apply the appropriate shrinkage compensation.

For simple cores, make a two-piece core box. Create a rectangular block that is 25 - 50mm (1 - 2 inches) larger than the core on all sides. Create the mold cavity by subtracting the core model from the block. Then split the block along the desired parting line (Figure 17). For positive location between the mold halves, add locator pins in side A and receiving holes in side B.



Figure 15: Making gating and runner system as a separate piece; it may be interchanged with alternate configurations.

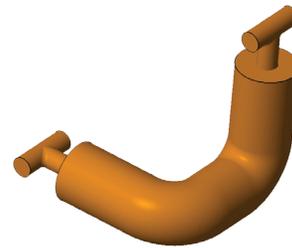


Figure 16: CAD model of core with core plugs.

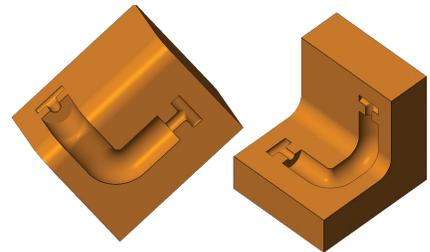


Figure 17: Core box CAD model.

# FDM FOR SAND CASTING

Complex cores may require multi-part molds (Figure 18). When core extraction is difficult, consider incorporating removable side panels (Figure 19).

### 3.6. RESIN (EPOXY OR URETHANE) PATTERNS

Resin patterns can offer high compressive strength, good bending strength and good abrasion resistance. When these characteristics are needed, use FDM to make a master of the pattern. The master is used to create a mold cavity from RTV (Figure 20). Since one RTV mold can create multiple patterns, this is also an option when running multiple molding machines or for production runs that will exceed the life of an FDM pattern.

Follow the design guidelines for the matchplate pattern. Next, create a bounding box that is 50.8 mm (2 inches) larger than the matchplate pattern on all sides. Fill this bounding box half full with an RTV casting material. Place the pattern in the RTV and finish filling the bounding box that was created. Vacuum or vibration can be used to eliminate air pockets in the casting material. Let the RTV casting material cure then split the casting along the desired parting line of the tool. Your result should be something like Figure 20. Add gates and vents

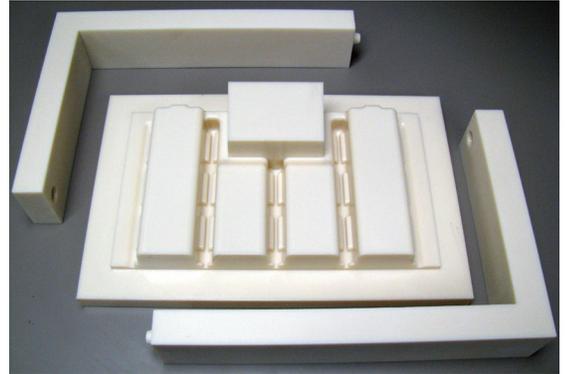


Figure 18: Core box.

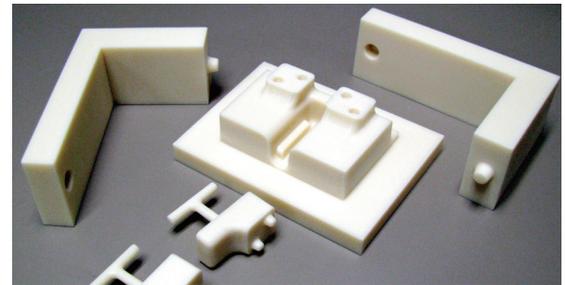


Figure 19: Removable side panels for easy extraction of sand core.

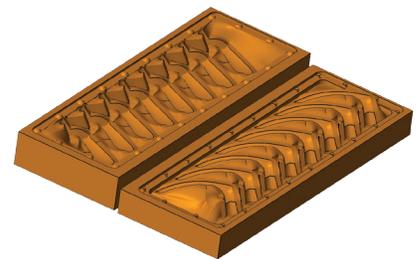


Figure 20: RTV silicone mold from FDM Master.

# FDM FOR SAND CASTING

for filling the mold with resin and allowing air to escape. Use this to mold one or many resin patterns from epoxy or urethane.

## 3.7. OTHER CONSIDERATIONS

### 3.6.1. SHRINKAGE

Considerations for shrink must be accounted for just as in the traditional process.

### 3.6.2. EXPORT STL

An STL must be exported from the CAD package for use with the FDM software. Ensure settings such as chord height, deviation and angle will produce a fine mesh. This will minimize the post processing efforts and preserve accuracy.

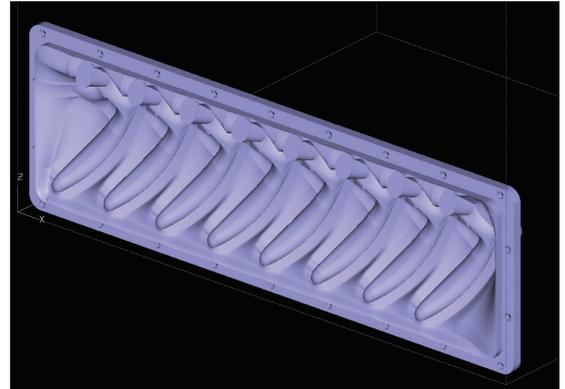


Figure 21: Open the pattern's STL file in Insight.

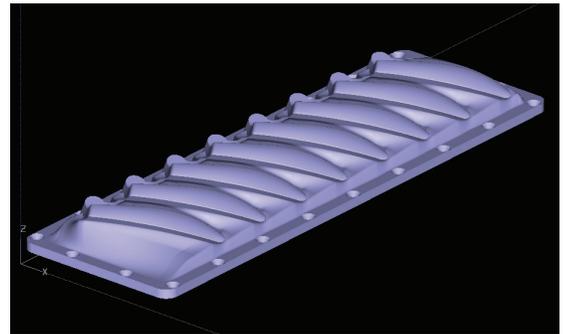


Figure 22: Orient the pattern with consideration for both surface finish and total process time.

## 4. FILE PREPARATION

### 4.1. IN INSIGHT, OPEN THE STL FILE FOR THE PATTERN (FIGURE 21).

#### 4.1.1. ORIENT PATTERN.

When orienting the pattern, consider both the surface finish and total process time (Figure 22). Fine-grained sand will capture surface imperfections so smooth surfaces are needed. While an orientation with a low Z height may decrease build time, it may increase the labor needed to post-process the pattern.

# FDM FOR SAND CASTING

## 4.1.2. SLICE THE FILE.

Select a slice height that balances surface smoothness, feature resolution and build time (Modeler > Setup). For moderate-sized patterns, 0.25 mm (0.010 in.) is suggested. For larger patterns, 0.50 mm (0.020 in.) may be advisable.

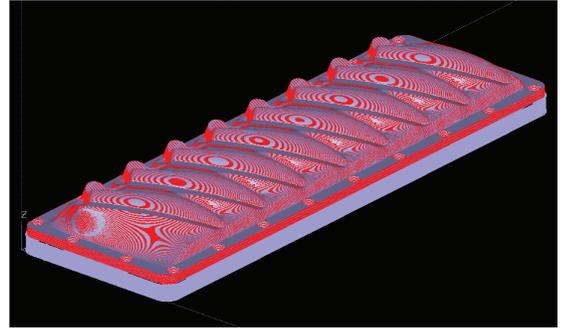


Figure 23: Specify slice height and slice file.

After making selection, slice the file (Figure 23).

## 4.2. PART INTERIOR STYLE

Set part interior style to “Solid-normal” (Modeler > Setup > Solid-normal).

When making sand molds, a solid fill style is recommended for matchplate patterns. This style maximizes the pattern’s resistance to compressive forces thereby reducing the possibility of insert damage when compacting sand.

If hand-ramming sand molds, Sparse or Sparse-double dense may be considered since the compaction forces are lower. Note: No testing with these styles has been performed so no data nor recommendations for their use currently exist.

For other pattern types and molds, the following part interior styles are recommended:

- Matchplate patterns – Due to force causing deflection, a solid-normal interior is recommended.
- Split patterns – Typically have lower stresses from deflection. Use “Sparse” or “Sparse-double dense”.

# FDM FOR SAND CASTING

- Loose patterns – Typically used in very low-volume situations. “Sparse” is sufficient.
- Gates and runners – “Sparse” is sufficient due to the pattern-backing support.
- Core boxes – Use “Sparse” because there will be low forces exerted on the molds.
- Resin patterns – Use “Sparse”. There will be little force when creating the RTV mold.



Figure 24: ABS-M30 is one of three recommended materials for green sand casting.

### 4.3. VISIBLE SURFACE STYLE

Set visible surface style to “Enhanced” mode (Modeler > Setup > Enhanced). Enhanced mode uses small rasters for the toolpaths of external visible surfaces. Internally, it uses thicker rasters. This style improves surface finish which decreases the time needed for surface smoothing while decreasing build time. Enhanced mode allows adjustment of the raster widths but the default settings are suitable for sand casting patterns.

### 4.4. CREATE SUPPORTS AND TOOLPATHS.

## 5. MATERIALS

Any FDM material can be used for sand cast patterns however the most commonly used materials are:

MATERIAL	BEST FIT
ABS-M30	Easiest to finish; lowest cost; up to 20.7 MPa (3,000 PSI)
PC	Good compromise of strength and cost; most abrasion resistant; up to 41.4 MPa (6,000 PSI)
ULTEM™ 9085 thermoplastic resin	Strongest material; naturally lubricious; up to 68.9 MPa (10,000 PSI)

# FDM FOR SAND CASTING

## 6. PATTERN PREPARATION

### 6.1. REMOVE SUPPORTS.

Following the FDM build, begin the pattern preparation by removing the support structures. These may be removed manually, or if soluble supports are used, by dissolving them.

### 6.2. SMOOTH MOLDING SURFACES.

Sand surfaces to desired smoothness. If you are using ABS for insert production, you may also use solvent smoothing.

#### 6.2.1. SANDING (FIGURE 25)

Begin with 120- to 320-grit sand paper. Next, fill in all depressions and layer lines using body filler, glazing putty or spot putty. After the filler has dried, sand all surfaces to the desired smoothness.



Figure 25: After support removal, smooth pattern surfaces.

#### 6.2.2. SOLVENT SMOOTHING (ABS MATERIALS ONLY)

If available, use the Finishing Touch Smoothing Station (Figure 37) to prepare the pattern. This is a labor-free process that can be completed in less than five minutes. It yields a smooth surface finish while preserving dimensional accuracy.

Alternatively, apply a solvent to the pattern to smooth the surfaces. This may be brushed onto the pattern or the pattern can be dipped into it. Avoid pooling and limit the duration of exposure since the solvent will begin to degrade feature details and dimensional accuracy.

# FDM FOR SAND CASTING

With either method, allow the pattern to harden for two hours before doing any other pattern processing. Before putting the pattern into service, allow it to rest for at least 24 hours.

## 6.3. ASSEMBLE PATTERNS.

Mount the FDM insert on the metal matchplate blank (Figures 26 and 27). Bolt the insert to the blank using firm but not excessive torque. Overtightening may cause the FDM insert to crack. Optionally, insert a metal bushing in each bolt hole to prevent excessive compression.



Figure 26: Mount (bolt) FDM insert to machined matchplate blank.

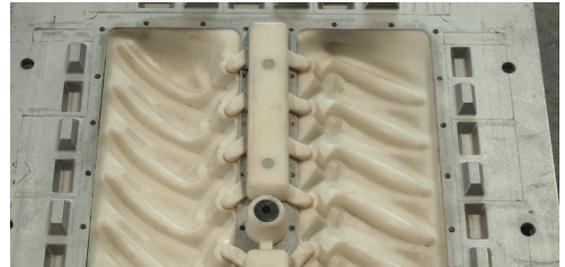


Figure 27: Complete matchplate (drag side shown) with two pattern inserts and removable gate/runner system.

If using interchangeable gates and runners, bolt them to the blank.

Attach matchplate inserts, split patterns or resin patterns to pattern boards or blanks with bolts or adhesives. Loose patterns do not require assembly.

If using FDM core boxes, mate the mold pieces after packing sand and proceed to the sand curing process. For resin pattern molds, simply mate the two mold halves and tape together.

## 6.4. APPLY TOP COAT (OPTIONAL).

Following manufacturer's instructions, apply a top coat like Master Foundry-Kote to the FDM pattern in order to seal the pores which will



Figure 28: Apply a top coat to seal pores and provide added abrasion resistance.

# FDM FOR SAND CASTING

prevent sand from tearing (Figure 28). This will also provide additional abrasion and chemical resistance.

## 6.5. APPLY RELEASE AGENT.

The last step before mold making is to apply a release agent to the pattern. If using the optional top coat, use any release agent you have traditionally used in your sand casting process. If applying the release agent directly to the FDM pattern, determine compatibility prior to application.

## 7. MOLD MAKING AND CASTING

Once the pattern has been prepared, there are no additional alterations needed for either the mold making or casting processes.

### 7.1. MOLD MAKING

Mount the pattern in an automated molding machine (Figures 29 and 30). As noted earlier, recommended pressures are below 20.7 MPa (3,000 psi) for an ABS FDM pattern with solid fill. If using sparse fill options, maximum pressures may be lower.



Figure 29: Mount matchplate in automated molding machine.



Figure 30: Matchplate in automated molding machine.



Figure 31: Cope side of sand mold for window handle.

# FDM FOR SAND CASTING

The molding machine will produce the cope and drag sides of the mold (Figure 31) and assemble them (Figure 32). If ripping occurs — when sand pulls off of the cope or drag as the pattern is extracted — reapply the face coat material.

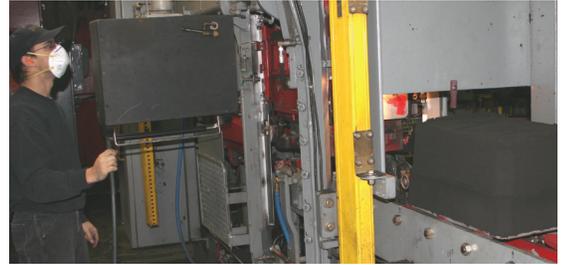


Figure 32: Complete green sand molds for window handle.

## 7.2. CASTING

Complete production of sand cast parts by:

- Casting the metal alloy into the sand mold (Figure 33)
- Breaking out castings from sand mold (Figure 34)
- Cutting off gates (Figure 35)
- Finishing to specification (Figure 36)



Figure 33: Cast metal alloy.



Figure 34: Break out castings from sand mold.

## 8. TOOLS & SUPPLIES

### 8.1. REQUIRED ITEMS:

- No additional tools or supplies are required.

### 8.2. OPTIONAL ITEMS:

- Top coat (Master Foundry-Kote)
- Finishing Touch Smoothing Station (Figure 37)



Figure 35: Cut off gates.

# FDM FOR SAND CASTING

- Solvents (MEK, Acetone, Micro-Mark’s Same Stuff, Weld-On #3 and similar)

### 8.3. SOURCES:

- Master Foundry-Kote: Freeman Manufacturing & Supply Company ([www.freemansupply.com](http://www.freemansupply.com))
- Finishing Touch Smoothing Station: StratasyS



Figure 36: Raw window handle castings ready for finishing.

## 9. KEY PROCESS CONSIDERATIONS

### 9.1. RESOLUTION DETAILS

The following table presents common obstacles to part production and recommended solutions.

OBSTACLE		RESOLUTION					
		LIGHTS-OUT OPERATIONS	DESIGN FOR FDM	PROCESS CONTROL	SECONDARY PROCESSES	PART ORIENTATION	MATERIAL SELECTION
Build Time	Throughput not competitive with machining.	✓	✓	✓		✓	
Porosity	Release agent wicks into pattern causing sand to stick.		✓	✓	✓		
Accuracy	Dimensional accuracy does not meet casting specifications.		✓		✓	✓	
Surface Finish	Visible layers and toolpaths cause sand tearing or result in poor casting finish			✓	✓	✓	
Material Cost	Pattern cost exceeds program budget allowance		✓	✓			✓
Small Features	Resolution is too coarse to replicate.		✓	✓	✓		
Part Properties	Pattern deflects or cracks during compaction. Surface abrasion yields short pattern life.			✓	✓		✓

Table 1: Common obstacles and resolutions

- “Lights-out” operations
  - Increase throughput and efficiency by managing job scheduling to leverage “lights-out”

# FDM FOR SAND CASTING

automated operations.

- Design for FDM
  - Design patterns to optimize the FDM process: self-supporting angles, offset surfaces, variable density, material removal and wall thicknesses.
  - Design pattern considering build orientation.
- Process control
  - Use advanced Insight tools for fill styles, custom groups (e.g., strength, porosity, material expense and build time).
  - Use fill styles recommended for each pattern type.
  - Select appropriate slice heights for feature size, surface finish and build time.
- Secondary processes
  - For surface smoothness: solvent smoothing, secondary machining, sanding, filling (body fillers) or coating (epoxy)
  - For porosity: solvent smoothing, epoxy coating or top coating (Master Foundry-Kote)
  - For accuracy: secondary machining
  - For abrasion and chemical resistance: Apply a top coat



Figure 37: Finishing Touch Smoothing Station.



Figure 38: Finished product: window handle with latch plate.

# FDM FOR SAND CASTING

- Part orientation
  - Position part to improve feature accuracy, surface finish and strength.
- Material selection
  - Select best material to meet performance requirements (i.e., compaction pressure, pattern life) instead of defaulting to what is in the machine.

## 10. RECAP - CRITICAL SUCCESS FACTORS

### 10.1. ACTIONS

- Follow good FDM practices.
- Use matchplate blank (metal) with FDM insert.
- Increase wall thickness in deep draw regions.
- Follow standard sand casting guidelines.

### 10.2. OPTIMIZE PATTERNS

- Strength and durability
- Build time and material cost
- Finishing and surface smoothing

### 10.3. ELIMINATE ADOPTION OBSTACLES

- Reasonably sized patterns
  - Avoid small, finely detailed and large (i.e., bigger than FDM system) patterns.
- Sand sticking to pattern
  - Smooth and coat pattern.
  - Apply adequate release agent.
- Pattern deflection and cracking
  - Make robust FDM patterns and stabilize with metal blanks.

## CONTACT:

To obtain more information on this application, contact:

### Stratasys Application Engineering

[www.stratasys.com/solutions-applications](http://www.stratasys.com/solutions-applications)

[info@stratasys.com](mailto:info@stratasys.com)

STRATASYS.COM

---

### HEADQUARTERS

7665 Commerce Way, Eden Prairie, MN 55344

+1 888 480 3548 (US Toll Free)

+1 952 937 3000 (Intl)

+1 952 937 0070 (Fax)

2 Holtzman St., Science Park, PO Box 2496

Rehovot 76124, Israel

+972 74 745-4000

+972 74 745-5000 (Fax)

# stratasys®

THE 3D PRINTING SOLUTIONS COMPANY

ISO 9001:2008 Certified

© 2013 Stratasys Inc. All rights reserved. Stratasys, FDM and Fortus are registered trademarks and Fused Deposition Modeling, FDM Technology, Fortus 250mc, Fortus 360mc, Fortus 400mc, Fortus 900mc, Insight and Control Center are trademarks of Stratasys Inc., registered in the United States and other countries. ULTEM™ is a registered trademark of SABIC or affiliates. All other trademarks are the property of their respective owners. Product specifications subject to change without notice. TAG\_FDM\_SandCasting\_EN\_0915.

The information contained herein is for general reference purposes only and may not be suitable for your situation. As such, Stratasys does not warranty this information. For assistance concerning your specific application, consult a Stratasys application engineer. To ensure user safety, Stratasys recommends reading, understanding, and adhering to the safety and usage directions for all Stratasys and other manufacturers' equipment and products. In addition, when using products like paints, solvents, epoxies, Stratasys recommends that users perform a product test on a sample part or a non-critical area of the final part to determine product suitability and prevent part damage.

For more information about Stratasys systems, materials and applications, call 888.480.3548 or visit [www.stratasys.com](http://www.stratasys.com)