

**Manufacturing Insights**

Rapid Castings:

Rapid Prototypes for Metal Casting Processes

SCENE 1.

**RC45A**, CGS: Sand Casting

**MI BKGD**, MI background

**RC45B, RC10, 14:34:46:00-14:35:02:00**

zoom in, pouring sand casting mold

SCENE 2.

continue previous shot

**RC46A, RC11, 16:01:24:00-16:01:47:00**

sand mold casting broken from mold

**RC46B, RC11, 16:02:45:00-16:03:15:00**

sand poured, pack against tool

**NARRATION (VO) :**

LIKE INVESTMENT CASTINGS, SAND CASTINGS ARE MADE FROM A SINGLE-USE MOLD THAT IS BROKEN APART AFTER THE METAL PART HAS BEEN POURED. THE PROCESS DIFFERENCES INCLUDE THE MOLD BEING MADE OF SAND, NOT CERAMIC, AND THE SAND IS PACKED AGAINST A RIGID TOOL, WHICH MEANS NO PATTERNS TO DIP IN SLURRY OR BURN OUT OF THE MOLD.

SCENE 3.

**RC47A, RC11, 16:10:12:00-16:10:22:00**

c.u. rapid prototyping in sand mold, pulled out

**RC47B, RC13, 18:50:17:00-18:50:34:00**

printing molds at ford

**RC47C**, CGS: Paul Susalla

Section Supervisor-Rapid  
Manufacturing

Prototype Operations

Ford Motor Company

**RC47D, RC14, 19:01:38:00-19:02:34:00**

paul susalla on camera

**NARRATION (VO) :**

AND WHILE RAPID PROTOTYPING PATTERNS CAN BE USED TO FORM THE SAND MOLDS, FORD MOTOR COMPANY APPROACHES THE MOLD MAKING PROCESS IN A VERY DIFFERENT WAY. IT PRINTS ITS MOLDS. PAUL SUSALLA EXPLAINS THEIR PROCESS.

SCENE 4.

continue previous shot

**RC48A, RC14, 19:51:50:00-19:52:04:00**

core in cad

**RC48B, RC14, 19:53:48:00-19:53:57:00**

multiplying cores in cad

**RC48C, RC13, 18:36:21:00-18:36:30:00**

zoom out, cores finished in job box, sand vacuumed away

**RC48D, RC18, 02:05:10:00-02:05:20:00**

**PAUL SUSALLA (ON-CAM) :**

...We first get the CAD model from, say, Product Engineering. We work with the CAD model and make sure it has all the features that are necessary. We then quote three or four foundries, if it's foundry partners. We work with them to decide which company is going to cast the parts. We work with that company to create the CAD package for the casting,

zoom out, cores in drag at foundry  
**RC48E, RC18, 02:11:19:00-02:11:29:00**  
zoom in, pouring of mold

cope and drag and internal cores. We get that CAD package in, we put that file into our machine, and we print the CAD package into a sand mold. We then take that sand mold back to that foundry, pour the aluminum, iron, whatever, and then bring the casting typically in house for any machining that has to be done. Then we deliver that to Product Engineering.

SCENE 5.

**RC49A, RC13, 18:12:43:00-18:13:20:00**  
rapid prototyping mold at ford  
**RC49B, RC15, 20:15:30:00-20:15:48:00**  
zoom in, sand being vacuumed from around mold being

**NARRATION (VO) :**

FORD USES A RAPID PROTOTYPING TECHNOLOGY THAT PRINTS OBJECTS IN FOUNDRY SAND THAT HAS AN ACTIVATOR MIXED INTO IT. THIS RAPID PROTOTYPING TECHNOLOGY ELIMINATES THE STEPS NEEDED TO CREATE THE TRADITIONAL PATTERN TOOLING USED TO PRODUCE SAND MOLDS AND CORES.

SCENE 6.

**RC50A, RC14, 19:21:05:00-19:21:39:00**  
paul susalla on camera  
**RC50B, RC13, 18:39:25:00-18:40:39:00**  
zoom out, printing of two mold layers,  
edit at multiple points

**PAUL SUSALLA (ON-CAM) :**

...The machine will then lay a thin layer of sand about 12 thousandths thick. It will go back and compact that layer down. For the first few layers it will just lay sand. Once it starts to print the part, after it's compacted, a print head will come over and deposit binder, kind of like your 3D inkjet printer. It will print the binder on that layer. Once that layer is complete, it will put another 12 thousandths of sand down, compact it, and go through the process over and over again.

SCENE 7.

**RC51A, RC15, 20:05:31:00-20:05:45:00**  
finished job box coming out of machine  
**RC51B, RC15, 20:12:18:00-20:12:59:00**  
cope pulled from job box, cleaned  
**RC51C, RC15, 20:21:09:00-20:21:23:00**  
zoom out, cope and drag  
**RC51D, RC14, 19:29:45:00-19:30:58:00**  
paul susalla on camera

**NARRATION (VO) :**

IN APPROXIMATELY TWO DAYS, THE RAPID PROTOTYPED TOOLING IS COMPLETE. THE MOLD PARTS ARE CAREFULLY REMOVED FROM THE JOB BOX, AND CLEANED OF ANY LOOSE SAND BEFORE CASTING. THIS DIRECT TOOLING PROCESS COMPLETELY ELIMINATES THE

LENGTHY DEVELOPMENT APPROACH TO  
PRODUCING TRADITIONAL SAND CAST TOOLING.  
PAUL SUSALLA SHARES AN UNEXPECTED  
BENEFIT OF DIRECT TOOLING DURING THE  
PROTOTYPING PROCESS.

SCENE 8.  
continue previous shot

**PAUL SUSALLA (ON-CAM) :**

...this windage tray is part of one of our engines. During the early prototype phases they noticed they had some aeration in the engine in the oil. So the product engineer came to us with a part very much like this, took a sharpee marker and said I want this changed, take this out, add material here. In our operations we have a CAD system, so our technologist went through and created the changes in CAD, sent that to the foundry, got the core package, the sand package that would go around this for the casting designed. We brought it into our machine, printed the packages, sent them back to the casting foundry. They made castings for us and put it right on test. This all happened in a matter of about a week or week and a half. That engineer was then able to go out and drive the vehicles with this new windage tray in it, came back and said I've got almost what I want, we have to do some more changes. So in a matter of a few weeks we were able to solve this issue, where traditionally it would have taken months to go through iterations of this.

SCENE 9.  
**RC53A, RC13, 18:31:17:00-18:31:35:00**  
job boxes on conveyor

**NARRATION (VO) :**

ANOTHER ADVANTAGE OF THE DIRECT TOOLING  
PROCESS IS ITS AUTOMATION INTEGRATION.

SCENE 10.  
**RC54A, RC14, 19:40:50:00-19:41:13:00**  
paul susalla on camera  
**RC54B, RC13, 19:00:14:00-19:00:26:00**  
zoom out, hopper system  
**RC54C, RC14, 19:36:37:00-19:36:53:00**  
paul susalla on camera  
**RC54D, RC15, 20:05:54:00-20:07:24:00**  
pan, trolley system bring job box out of  
machine, edit at multiple points  
**RC54E, RC14, 19:41:12:00-19:41:27:00**

**PAUL SUSALLA (ON-CAM) :**

The machines themselves are designed to run unattended. We have a hopper system for the sand that will supply four machines' full job boxes without intervention. So we can set up and fill that hopper and run continuously, once we get the machine started, unattended, until they're complete...  
...Another thing we have going for us is, we have a trolley system with our

paul susalla on camera

job boxes, so we can move job boxes in and out and bring them into a breakout station to actually take the parts out of the sand...

...What that allows us to do is, we run basically a one shift operation here. We set the machines up so that they need attendance when we have people here. Otherwise, they can run 24/7 unattended.

SCENE 11.

**RC55A, RC13, 18:48:38:00-18:49:19:00**  
sand cast printing

**NARRATION (VO) :**

SINCE FORD PRINTS ONE SAND MOLD FOR EACH METAL CASTING, THE PROCESS IS SCALABLE, ALLOWING THEM TO MOVE TO PRODUCTION TOOLING SOON AFTER VALIDATING THE DESIGN.

SCENE 12.

continue previous shot  
**RC56A, RC14, 19:26:34:00-19:27:23:00**  
paul susalla on camera  
**RC56B, RC13, 18:25:48:00-18:26:13:00**  
sand cast printing

**PAUL SUSALLA (ON-CAM) :**

...If we are making 2 or 3 cylinder heads, we may print the entire package. The big parts, the cope and the drag, and all the internal parts. That's the simplest way to get a couple of castings. If we're going to go up to 100 cylinder heads or something like that, it's not necessarily cost effective to print all the big parts, but it still is cost effective to print all the internals. At that point we step into the next portion of scalability, and we will go and cut tooling for the larger parts, the larger, simpler parts, and the smaller, intricate parts we will still print in our process. As we get farther and farther up in the higher quantities, at some point you need to go tool everything for production.

SCENE 13.

**RC57A, RC14, 19:27:49:00-19:28:50:00**  
paul susalla on camera  
**RC57B, RC13, 18:14:56:00-18:15:13:00**  
zoom in, direct mold making process  
**RC57C, RC13, 18:09:25:00-18:09:42:00**  
zoom out, cores in job box  
**RC57D, RC18, 02:14:26:00-02:14:32:00**  
zoom out, small mold half  
**RC57E, RC18, 02:12:58:00-02:13:07:00**  
pouring of sand printed mold  
**RC57F, RC18, 02:16:04:00-02:16:26:00**  
part broken out of mold

**PAUL SUSALLA (ON-CAM) :**

There are several factors in the decision to use the sand printing for rapid prototype casting. One of them is the speed. How fast do you need a part? If you need a part extremely quickly, you're not going to be able to do it with tooling, so it's the only way to go. Other factors that will influence whether you use this, or a hybrid, or completely traditionally tooled process is the size of the part, the complexity of the part, and how many you need. For example, if you have very intricate,

small parts, it makes a lot of sense to use sand printing, even up to a high volume. Because to tool something that intricate is very expensive. If you have something that's large and fairly simple, the cost equation dictates that once you up past a few, it makes sense to tool those larger parts. So it's really a factor of complexity, size, quantity, and how fast you need the parts.

SCENE 14.

**RC58A, RC13, 18:40:49:00-18:41:40:00**  
zoom out, direct mold making process

**NARRATION (VO) :**

PAUL SUSALLA EXPLAINS THE ADVANTAGES OF THEIR RAPID CASTING PROCESS ON PRODUCT DEVELOPMENT CYCLE TIME.

SCENE 15.

**RC59A, RC14, 19:18:00:00-19:18:55:00**  
paul susalla on camera

**PAUL SUSALLA (ON-CAM) :**

Traditional casting processes for a prototype might take 2, 3, 4 months to get the design, machine the tooling, cast it, machine it, and then get that part on test. An example of where we were able to streamline that process is, over the summer we did an exhaust manifold for one of our product teams. They came to us with a design and it was one of those things where they said we need this as quickly as possible because we have some iterations to do and this is a brand new concept. We were able to take that from the CAD model to a machine casting in seven days. They were able to get that part on test, and within a couple days they determined they needed some modifications. They gave us a new model, and within another week we had another part ready for them to test. So within a matter of two weeks we were able to get them a couple of iterations, where in the traditional process, they would still have been waiting a couple months for the first one.

SCENE 16.

**RC60A, RC13, 18:11:24:00-18:11:35:00**  
pan rapid prototyping system, printing of sand mold

**NARRATION (VO) :**

OR, THEY CAN ITERATE WHILE, AND ALONGSIDE, THE PRODUCTION PROCESS.

SCENE 17.

**RC61A, RC14, 19:25:22:00-19:25:54:00**

**PAUL SUSALLA (ON-CAM) :**

An additional application that we have

paul susalla on camera

**RC61B, RC18, 02:13:41:00-02:13:57:00**

pouring of mold

**RC61C, RC14, 19:26:02:00-19:26:20:00**

paul susalla on camera

with this sand printing material, we can integrate this directly into our traditional foundry processes. For example, if we have a cylinder head that product engineering wants to change some cores, they want to change the water jacket. But it's already in production. We can print new water jacket cores and ship them down to the factory where they cast the cylinder heads, and they can integrate them directly into the production process...

~~...We can then ship cores down, introduce them right into the process,~~ actually come right through the exact same process out the end, including machining, so it is really a production part, but has new features.

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